



Amendment No. 1
to
Contract No. GA180000076
for
LED Traffic Lamps
between
Consolidated Traffic Controls Inc.
and the
City of Austin

- 1.0 The City hereby exercises the extension option for the above-referenced contract. Effective October 15, 2020 to October 14, 2021. Two options will remain.
- 2.0 The City hereby accepts the 2.23% price increase as requested by Consolidated Traffic Controls Inc. The increase and new unit price rates are listed in Attachment A. Effective date of this change is October 15, 2020.
- 3.0 The total Contract amount is increased by \$107,150.00 for the extension option period. The total Contract authorization is recapped below:

Term	Action Amount	Total Contract Amount
Basic Term: 10/15/2018 – 10/14/2020	\$214,300.00	\$214,300.00
Amendment No. 1: Option 1 10/15/2020 – 10/14/2021	\$107,150.00	\$321,450.00

- 4.0 By signing this Amendment, the Contractor certifies that the Contractor and its principals are not currently suspended or debarred from doing business with the Federal Government, as indicated by the General Services Administration (GSA) List of Parties Excluded from Federal Procurement and Non-Procurement Programs, the State of Texas, or the City of Austin.
- 5.0 All other terms and conditions remain the same.

BY THE SIGNATURES affixed below, this Amendment is hereby incorporated into and made a part of the above-referenced contract.

Signature & Date: Digitally signed by David G. Walker
DN: cn=David G. Walker, o=ou,
email=dgwalker@prodigy.net, c=US
Date: 2020.10.14 11:46:08 -05'00'

Printed Name:
Authorized Representative

Consolidated Traffic Controls Inc.
1016 Enterprise Place
Arlington, TX 76001
estimator@ctc-traffic.com
817-265-3421

Signature & Date: **Erin D'Vincent**
Erin D'Vincent, Procurement Supervisor
City of Austin
Purchasing Office
October 19, 2020

Digitally signed by Erin D'Vincent
DN: cn=Erin D'Vincent, o=City of Austin,
ou=Purchasing Office,
email=erin.dvincent@austintexas.gov, c=US
Date: 2020.10.19 09:46:58 -05'00'

**CONTRACT BETWEEN THE CITY OF AUSTIN ("City")
AND
Consolidated Traffic Controls Inc ("Contractor")
for
LED Traffic Lamps
MA 2400 GA180000076**

The City accepts the Contractor's Offer (as referenced in Section 1.1.3 below) for the above requirement and enters into the following Contract.

This Contract is between Consolidated Traffic Controls Inc having offices at 1016 Enterprise Place, Arlington, TX 76001 and the City, a home-rule municipality incorporated by the State of Texas, and is effective as of the date executed by the City ("Effective Date").

Capitalized terms used but not defined herein have the meanings given them in Solicitation Number IFB 2400 MDP0263.

1.1 This Contract is composed of the following documents:

- 1.1.1 This Contract
- 1.1.2 The City's Solicitation, Invitation for Bid (IFB), 2400 MDP0263 including all documents incorporated by reference
- 1.1.3 Consolidated Traffic Controls Inc Offer, dated May 1, 2018 including subsequent clarifications

1.2 Order of Precedence. Any inconsistency or conflict in the Contract documents shall be resolved by giving precedence in the following order:

- 1.2.1 This Contract
- 1.2.2 The City's Solicitation as referenced in Section 1.1.2, including all documents incorporated by reference
- 1.2.3 The Contractor's Offer as referenced in Section 1.1.3, including subsequent clarifications.

1.3 Term of Contract. The Contract will be in effect for an initial term of twenty-four (24) months and may be extended thereafter for up to three (3) twelve (12) month extension option(s), subject to the approval of the Contractor and the City Purchasing Officer or his designee. See the Term of Contract provision in Section 0400 for additional Contract requirements.

1.4 Compensation. The Contractor shall be paid a total Not-to-Exceed amount of \$214,300.00 for the initial Contract term and \$107,150.00 for each extension option for a total contract amount not to exceed \$535,750.00. Payment shall be made upon successful completion of services or delivery of goods as outlined in each individual Delivery Order.

1.5 Quantity of Work. There is no guaranteed quantity of work for the period of the Contract and there are no minimum order quantities. Work will be on an as needed basis as specified by the City for each Delivery Order.

This Contract (including any Exhibits) constitutes the entire agreement of the parties regarding the subject matter of this Contract and supersedes all prior and contemporaneous agreements and understandings, whether written or oral, relating to such subject matter. This Contract may be altered, amended, or modified only by a written instrument signed by the duly authorized representatives of both parties.

In witness whereof, the City has caused a duly authorized representative to execute this Contract on the date set forth below.

Consolidated Traffic Controls Inc

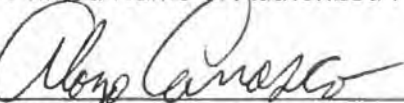
CITY OF AUSTIN

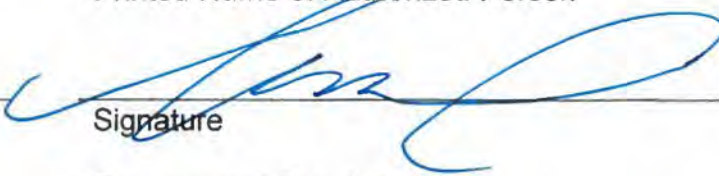
Alonzo Carrasco

Michelle D. Pearson

Printed Name of Authorized Person

Printed Name of Authorized Person





Signature

Signature

Sales Manager

Procurement Specialist II

Title

Title

10-09-18

10-15-18

Date

Date

Erin D Vincent

Printed Name of Authorized Person



Signature

Procurement Supervisor

Title

10-15-18

Date



CITY OF AUSTIN, TEXAS
Purchasing Office
INVITATION FOR BID (IFB)
OFFER SHEET

SOLICITATION NO: IFB 2400 MDP0263

COMMODITY/SERVICE DESCRIPTION: LED Traffic Lamps

DATE ISSUED: April 16, 2018

PRE-BID CONFERENCE TIME AND DATE: n/a

REQUISITION NO.: 18030800325

LOCATION: n/a

COMMODITY CODE: 55088

BID DUE PRIOR TO: May 3, 2018 at 2:00 PM Central

**FOR CONTRACTUAL AND TECHNICAL
ISSUES CONTACT THE FOLLOWING
AUTHORIZED CONTACT PERSON:**

BID OPENING TIME AND DATE: May 3, 2018 – 3:00 PM Central

Michelle Pearson
Procurement Specialist II
Phone: (512) 974-2023
E-Mail: michelle.pearson@austintexas.gov

LOCATION: MUNICIPAL BUILDING, 124 W 8th STREET
RM 308, AUSTIN, TEXAS 78701

Erin D'Vincent
Procurement Specialist IV
Phone: (512) 974-3070
E-Mail: erin.dvincent@austintexas.gov

LIVE BID OPENING ONLINE:

For information on how to attend the Bid Opening online, please select this link:

<http://www.austintexas.gov/department/bid-opening-webinars>

When submitting a sealed Offer and/or Compliance Plan, use the proper address for the type of service desired, as shown below:

Address for US Mail (Only)	Address for FedEx, UPS, Hand Delivery or Courier Service
City of Austin	City of Austin, Municipal Building
Purchasing Office-Response for Solicitation # IFB 2400 MDP0263	Purchasing Office-Response Enclosed for Solicitation # IFB 2400 MDP0263
P.O. Box 1088	124 W 8 th Street, Rm 308
Austin, Texas 78767-8845	Austin, Texas 78701
	Reception Phone: (512) 974-2500

NOTE: Offers must be received and time stamped in the Purchasing Office prior to the Due Date and Time. It is the responsibility of the Offeror to ensure that their Offer arrives at the receptionist's desk in the Purchasing Office prior to the time and date indicated. Arrival at the City's mailroom, mail terminal, or post office box will not constitute the Offer arriving on time. See Section 0200 for additional solicitation instructions.

All Offers (including Compliance Plans) that are not submitted in a sealed envelope or container will not be considered.

The Vendor agrees, if this Offer is accepted within 120 calendar days after the Due Date, to fully comply in strict accordance with the Solicitation, specifications and provisions attached thereto for the amounts shown on the accompanying Offer.

SUBMIT 1 ORIGINAL AND 1 ELECTRONIC COPY (USB FLASH DRIVE) OF YOUR RESPONSE

*****SIGNATURE FOR SUBMITTAL REQUIRED ON PAGE 3 OF THIS DOCUMENT*****

This solicitation is comprised of the following required sections. Please ensure to carefully read each section including those incorporated by reference. By signing this document, you are agreeing to all the items contained herein and will be bound to all terms.

SECTION NO.	TITLE	PAGES
0100	STANDARD PURCHASE DEFINITIONS	*
0200	STANDARD SOLICITATION INSTRUCTIONS	*
0300	STANDARD PURCHASE TERMS AND CONDITIONS	*
0400	SUPPLEMENTAL PURCHASE PROVISIONS	7
0500	SPECIFICATION	5
0600	BID SHEET – Must be completed and returned with Offer	1
0605	LOCAL BUSINESS PRESENCE IDENTIFICATION FORM – Complete & return	2
0700	REFERENCE SHEET – Complete and return	1
0800	NON-DISCRIMINATION AND NON-RETALIATION CERTIFICATION–Complete and return	2
0805	NON-SUSPENSION OR DEBARMENT CERTIFICATION	*
0810	NON-COLLUSION, NON-CONFLICT OF INTEREST, AND ANTI-LOBBYING CERTIFICATION	*
0835	NONRESIDENT BIDDER PROVISIONS – Complete & return	1
0900	SUBCONTRACTING/SUB-CONSULTING UTILIZATION FORM – Complete & return	1
0905	SUBCONTRACTING/SUB-CONSULTING UTILIZATION PLAN – Complete and return if applicable	3

*** Documents are hereby incorporated into this Solicitation by reference, with the same force and effect as if they were incorporated in full text. The full text versions of the * Sections are available on the Internet at the following online address:**

http://www.austintexas.gov/financeonline/vendor_connection/index.cfm#STANDARDBIDDOCUMENTS

If you do not have access to the Internet, you may obtain a copy of these Sections from the City of Austin Purchasing Office located in the Municipal Building, 124 West 8th Street, Room #308 Austin, Texas 78701; phone (512) 974-2500. Please have the Solicitation number available so that the staff can select the proper documents. These documents can be mailed, expressed mailed, or faxed to you.

The undersigned, by his/her signature, represents that he/she is submitting a binding offer and is authorized to bind the respondent to fully comply with the solicitation document contained herein. The Respondent, by submitting and

signing below, acknowledges that he/she has received and read the entire document packet sections defined above including all documents incorporated by reference, and agrees to be bound by the terms therein.

Company Name: Consolidated Traffic Controls, Inc.

Company Address: 1016 Enterprise Place

City, State, Zip: Arlington, TX 76001

Federal Tax ID No. [REDACTED]

Printed Name of Officer or Authorized Representative: Mark O'Barr

Title: Estimator

Signature of Officer or Authorized Representative: 

Date: May 1, 2018

Email Address: estimator@ctc-traffic.com

Phone Number: (817) 265-3421

*** Completed Bid Sheet, section 0600 must be submitted with this signed Offer Sheet to be considered for award**

**CITY OF AUSTIN
PURCHASING OFFICE
STANDARD PURCHASE TERMS AND CONDITIONS**

By submitting an Offer in response to the Solicitation, the Contractor agrees that the Contract shall be governed by the following terms and conditions. Unless otherwise specified in the Contract, Sections 3, 4, 5, 6, 7, 8, 20, 21, and 36 shall apply only to a Solicitation to purchase Goods, and Sections 9, 10, 11 and 22 shall apply only to a Solicitation to purchase Services to be performed principally at the City's premises or on public rights-of-way.

1. **CONTRACTOR'S OBLIGATIONS**. The Contractor shall fully and timely provide all Deliverables described in the Solicitation and in the Contractor's Offer in strict accordance with the terms, covenants, and conditions of the Contract and all applicable Federal, State, and local laws, rules, and regulations.
2. **EFFECTIVE DATE/TERM**. Unless otherwise specified in the Solicitation, this Contract shall be effective as of the date the contract is signed by the City, and shall continue in effect until all obligations are performed in accordance with the Contract.
3. **CONTRACTOR TO PACKAGE DELIVERABLES**: The Contractor will package Deliverables in accordance with good commercial practice and shall include a packing list showing the description of each item, the quantity and unit price. Unless otherwise provided in the Specifications or Supplemental Terms and Conditions, each shipping container shall be clearly and permanently marked as follows: (a) The Contractor's name and address, (b) the City's name, address and purchase order or purchase release number and the price agreement number if applicable, (c) Container number and total number of containers, e.g. box 1 of 4 boxes, and (d) the number of the container bearing the packing list. The Contractor shall bear cost of packaging. Deliverables shall be suitably packed to secure lowest transportation costs and to conform with requirements of common carriers and any applicable specifications. The City's count or weight shall be final and conclusive on shipments not accompanied by packing lists.
4. **SHIPMENT UNDER RESERVATION PROHIBITED**: The Contractor is not authorized to ship the Deliverables under reservation and no tender of a bill of lading will operate as a tender of Deliverables.
5. **TITLE & RISK OF LOSS**: Title to and risk of loss of the Deliverables shall pass to the City only when the City actually receives and accepts the Deliverables.
6. **DELIVERY TERMS AND TRANSPORTATION CHARGES**: Deliverables shall be shipped F.O.B. point of delivery unless otherwise specified in the Supplemental Terms and Conditions. Unless otherwise stated in the Offer, the Contractor's price shall be deemed to include all delivery and transportation charges. The City shall have the right to designate what method of transportation shall be used to ship the Deliverables. The place of delivery shall be that set forth in the block of the purchase order or purchase release entitled "Receiving Agency".
7. **RIGHT OF INSPECTION AND REJECTION**: The City expressly reserves all rights under law, including, but not limited to the Uniform Commercial Code, to inspect the Deliverables at delivery before accepting them, and to reject defective or non-conforming Deliverables. If the City has the right to inspect the Contractor's, or the Contractor's Subcontractor's, facilities, or the Deliverables at the Contractor's, or the Contractor's Subcontractor's, premises, the Contractor shall furnish, or cause to be furnished, without additional charge, all reasonable facilities and assistance to the City to facilitate such inspection.
8. **NO REPLACEMENT OF DEFECTIVE TENDER**: Every tender or delivery of Deliverables must fully comply with all provisions of the Contract as to time of delivery, quality, and quantity. Any non-complying tender shall constitute a breach and the Contractor shall not have the right to substitute a conforming tender; provided, where the time for performance has not yet expired, the Contractor may notify the City of the intention to cure and may then make a conforming tender within the time allotted in the contract.
9. **PLACE AND CONDITION OF WORK**: The City shall provide the Contractor access to the sites where the Contractor is to perform the services as required in order for the Contractor to perform the services in a timely and efficient manner, in accordance with and subject to the applicable security laws, rules, and regulations. The Contractor acknowledges that it has satisfied itself as to the nature of the City's service requirements and specifications, the location and essential characteristics of the work sites, the quality and quantity of materials, equipment, labor and facilities necessary to perform the services, and any other condition or state of fact which could in any way affect performance of the Contractor's obligations under the contract. The Contractor hereby releases and holds the City

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harmless from and against any liability or claim for damages of any kind or nature if the actual site or service conditions differ from expected conditions.

10. WORKFORCE

- A. The Contractor shall employ only orderly and competent workers, skilled in the performance of the services which they will perform under the Contract.
- B. The Contractor, its employees, subcontractors, and subcontractor's employees may not while engaged in participating or responding to a solicitation or while in the course and scope of delivering goods or services under a City of Austin contract or on the City's property .
 - i. use or possess a firearm, including a concealed handgun that is licensed under state law, except as required by the terms of the contract; or
 - ii. use or possess alcoholic or other intoxicating beverages, illegal drugs or controlled substances, nor may such workers be intoxicated, or under the influence of alcohol or drugs, on the job.
- C. If the City or the City's representative notifies the Contractor that any worker is incompetent, disorderly or disobedient, has knowingly or repeatedly violated safety regulations, has possessed any firearms, or has possessed or was under the influence of alcohol or drugs on the job, the Contractor shall immediately remove such worker from Contract services, and may not employ such worker again on Contract services without the City's prior written consent.

- 11. COMPLIANCE WITH HEALTH, SAFETY, AND ENVIRONMENTAL REGULATIONS:** The Contractor, its Subcontractors, and their respective employees, shall comply fully with all applicable federal, state, and local health, safety, and environmental laws, ordinances, rules and regulations in the performance of the services, including but not limited to those promulgated by the City and by the Occupational Safety and Health Administration (OSHA). In case of conflict, the most stringent safety requirement shall govern. The Contractor shall indemnify and hold the City harmless from and against all claims, demands, suits, actions, judgments, fines, penalties and liability of every kind arising from the breach of the Contractor's obligations under this paragraph.

12. INVOICES:

- A. The Contractor shall submit separate invoices in duplicate on each purchase order or purchase release after each delivery. If partial shipments or deliveries are authorized by the City, a separate invoice must be sent for each shipment or delivery made.
- B. **Proper Invoices must include a unique invoice number, the purchase order or delivery order number and the master agreement number if applicable, the Department's Name, and the name of the point of contact for the Department.** Invoices shall be itemized and transportation charges, if any, shall be listed separately. A copy of the bill of lading and the freight waybill, when applicable, shall be attached to the invoice. The Contractor's name and, if applicable, the tax identification number on the invoice must exactly match the information in the Vendor's registration with the City. Unless otherwise instructed in writing, the City may rely on the remittance address specified on the Contractor's invoice.
- C. Invoices for labor shall include a copy of all time-sheets with trade labor rate and Deliverables order number clearly identified. Invoices shall also include a tabulation of work-hours at the appropriate rates and grouped by work order number. Time billed for labor shall be limited to hours actually worked at the work site.
- D. Unless otherwise expressly authorized in the Contract, the Contractor shall pass through all Subcontract and other authorized expenses at actual cost without markup.
- E. Federal excise taxes, State taxes, or City sales taxes must not be included in the invoiced amount. The City will furnish a tax exemption certificate upon request.

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13. PAYMENT:

- A. All proper invoices received by the City will be paid within thirty (30) calendar days of the City's receipt of the Deliverables or of the invoice, whichever is later.
- B. **If payment is not timely made, (per paragraph A), interest shall accrue on the unpaid balance at the lesser of the rate specified in Texas Government Code Section 2251.025 or the maximum lawful rate; except, if payment is not timely made for a reason for which the City may withhold payment hereunder, interest shall not accrue until ten (10) calendar days after the grounds for withholding payment have been resolved.**
- C. If partial shipments or deliveries are authorized by the City, the Contractor will be paid for the partial shipment or delivery, as stated above, provided that the invoice matches the shipment or delivery.
- D. The City may withhold or set off the entire payment or part of any payment otherwise due the Contractor to such extent as may be necessary on account of:
 - i. delivery of defective or non-conforming Deliverables by the Contractor;
 - ii. third party claims, which are not covered by the insurance which the Contractor is required to provide, are filed or reasonable evidence indicating probable filing of such claims;
 - iii. failure of the Contractor to pay Subcontractors, or for labor, materials or equipment;
 - iv. damage to the property of the City or the City's agents, employees or contractors, which is not covered by insurance required to be provided by the Contractor;
 - v. reasonable evidence that the Contractor's obligations will not be completed within the time specified in the Contract, and that the unpaid balance would not be adequate to cover actual or liquidated damages for the anticipated delay;
 - vi. failure of the Contractor to submit proper invoices with all required attachments and supporting documentation; or
 - vii. failure of the Contractor to comply with any material provision of the Contract Documents.
- E. Notice is hereby given of Article VIII, Section 1 of the Austin City Charter which prohibits the payment of any money to any person, firm or corporation who is in arrears to the City for taxes, and of §2-8-3 of the Austin City Code concerning the right of the City to offset indebtedness owed the City.
- F. Payment will be made by check unless the parties mutually agree to payment by credit card or electronic transfer of funds. The Contractor agrees that there shall be no additional charges, surcharges, or penalties to the City for payments made by credit card or electronic funds transfer.
- G. The awarding or continuation of this contract is dependent upon the availability of funding. The City's payment obligations are payable only and solely from funds Appropriated and available for this contract. The absence of Appropriated or other lawfully available funds shall render the Contract null and void to the extent funds are not Appropriated or available and any Deliverables delivered but unpaid shall be returned to the Contractor. The City shall provide the Contractor written notice of the failure of the City to make an adequate Appropriation for any fiscal year to pay the amounts due under the Contract, or the reduction of any Appropriation to an amount insufficient to permit the City to pay its obligations under the Contract. In the event of non or inadequate appropriation of funds, there will be no penalty nor removal fees charged to the City.

- 14. TRAVEL EXPENSES:** All travel, lodging and per diem expenses in connection with the Contract for which reimbursement may be claimed by the Contractor under the terms of the Solicitation will be reviewed against the City's Travel Policy as published and maintained by the City's Controller's Office and the Current United States General Services Administration Domestic Per Diem Rates (the "Rates") as published and maintained on the Internet at:

<http://www.gsa.gov/portal/category/21287>

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No amounts in excess of the Travel Policy or Rates shall be paid. All invoices must be accompanied by copies of detailed itemized receipts (e.g. hotel bills, airline tickets). No reimbursement will be made for expenses not actually incurred. Airline fares in excess of coach or economy will not be reimbursed. Mileage charges may not exceed the amount permitted as a deduction in any year under the Internal Revenue Code or Regulations.

15. FINAL PAYMENT AND CLOSE-OUT:

- A. If an MBE/WBE Program Compliance Plan is required by the Solicitation, and the Contractor has identified Subcontractors, the Contractor is required to submit a Contract Close-Out MBE/WBE Compliance Report to the Project manager or Contract manager no later than the 15th calendar day after completion of all work under the contract. Final payment, retainage, or both may be withheld if the Contractor is not in compliance with the requirements of the Compliance Plan as accepted by the City.
- B. The making and acceptance of final payment will constitute:
 - i. a waiver of all claims by the City against the Contractor, except claims (1) which have been previously asserted in writing and not yet settled, (2) arising from defective work appearing after final inspection, (3) arising from failure of the Contractor to comply with the Contract or the terms of any warranty specified herein, (4) arising from the Contractor's continuing obligations under the Contract, including but not limited to indemnity and warranty obligations, or (5) arising under the City's right to audit; and
 - ii. a waiver of all claims by the Contractor against the City other than those previously asserted in writing and not yet settled.

16. SPECIAL TOOLS & TEST EQUIPMENT: If the price stated on the Offer includes the cost of any special tooling or special test equipment fabricated or required by the Contractor for the purpose of filling this order, such special tooling equipment and any process sheets related thereto shall become the property of the City and shall be identified by the Contractor as such.

17. AUDITS and RECORDS:

- A. The Contractor agrees that the representatives of the Office of the City Auditor or other authorized representatives of the City shall have access to, and the right to audit, examine, or reproduce, any and all records of the Contractor related to the performance under this Contract. The Contractor shall retain all such records for a period of three (3) years after final payment on this Contract or until all audit and litigation matters that the City has brought to the attention of the Contractor are resolved, whichever is longer. The Contractor agrees to refund to the City any overpayments disclosed by any such audit.
- B. Records Retention:
 - i. Contractor is subject to City Code chapter 2-11 (Records Management), and as it may subsequently be amended. For purposes of this subsection, a Record means all books, accounts, reports, files, and other data recorded or created by a Contractor in fulfillment of the Contract whether in digital or physical format, except a record specifically relating to the Contractor's internal administration.
 - ii. All Records are the property of the City. The Contractor may not dispose of or destroy a Record without City authorization and shall deliver the Records, in all requested formats and media, along with all finding aids and metadata, to the City at no cost when requested by the City
 - iii. The Contractor shall retain all Records for a period of three (3) years after final payment on this Contract or until all audit and litigation matters that the City has brought to the attention of the Contractor are resolved, whichever is longer.
- C. The Contractor shall include sections A and B above in all subcontractor agreements entered into in connection with this Contract.

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18. SUBCONTRACTORS:

- A. If the Contractor identified Subcontractors in an MBE/WBE Program Compliance Plan or a No Goals Utilization Plan the Contractor shall comply with the provisions of Chapters 2-9A, 2-9B, 2-9C, and 2-9D, as applicable, of the Austin City Code and the terms of the Compliance Plan or Utilization Plan as approved by the City (the "Plan"). The Contractor shall not initially employ any Subcontractor except as provided in the Contractor's Plan. The Contractor shall not substitute any Subcontractor identified in the Plan, unless the substitute has been accepted by the City in writing in accordance with the provisions of Chapters 2-9A, 2-9B, 2-9C and 2-9D, as applicable. No acceptance by the City of any Subcontractor shall constitute a waiver of any rights or remedies of the City with respect to defective Deliverables provided by a Subcontractor. If a Plan has been approved, the Contractor is additionally required to submit a monthly Subcontract Awards and Expenditures Report to the Contract Manager and the Purchasing Office Contract Compliance Manager no later than the tenth calendar day of each month.
- B. Work performed for the Contractor by a Subcontractor shall be pursuant to a written contract between the Contractor and Subcontractor. The terms of the subcontract may not conflict with the terms of the Contract, and shall contain provisions that:
 - i. require that all Deliverables to be provided by the Subcontractor be provided in strict accordance with the provisions, specifications and terms of the Contract;
 - ii. prohibit the Subcontractor from further subcontracting any portion of the Contract without the prior written consent of the City and the Contractor. The City may require, as a condition to such further subcontracting, that the Subcontractor post a payment bond in form, substance and amount acceptable to the City;
 - iii. require Subcontractors to submit all invoices and applications for payments, including any claims for additional payments, damages or otherwise, to the Contractor in sufficient time to enable the Contractor to include same with its invoice or application for payment to the City in accordance with the terms of the Contract;
 - iv. require that all Subcontractors obtain and maintain, throughout the term of their contract, insurance in the type and amounts specified for the Contractor, with the City being a named insured as its interest shall appear; and
 - v. require that the Subcontractor indemnify and hold the City harmless to the same extent as the Contractor is required to indemnify the City.
- C. The Contractor shall be fully responsible to the City for all acts and omissions of the Subcontractors just as the Contractor is responsible for the Contractor's own acts and omissions. Nothing in the Contract shall create for the benefit of any such Subcontractor any contractual relationship between the City and any such Subcontractor, nor shall it create any obligation on the part of the City to pay or to see to the payment of any moneys due any such Subcontractor except as may otherwise be required by law.
- D. The Contractor shall pay each Subcontractor its appropriate share of payments made to the Contractor not later than ten (10) calendar days after receipt of payment from the City.

19. WARRANTY-PRICE:

- A. The Contractor warrants the prices quoted in the Offer are no higher than the Contractor's current prices on orders by others for like Deliverables under similar terms of purchase.
- B. The Contractor certifies that the prices in the Offer have been arrived at independently without consultation, communication, or agreement for the purpose of restricting competition, as to any matter relating to such fees with any other firm or with any competitor.
- C. In addition to any other remedy available, the City may deduct from any amounts owed to the Contractor, or otherwise recover, any amounts paid for items in excess of the Contractor's current prices on orders by others for like Deliverables under similar terms of purchase.

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20. **WARRANTY – TITLE:** The Contractor warrants that it has good and indefeasible title to all Deliverables furnished under the Contract, and that the Deliverables are free and clear of all liens, claims, security interests and encumbrances. The Contractor shall indemnify and hold the City harmless from and against all adverse title claims to the Deliverables.
21. **WARRANTY – DELIVERABLES:** The Contractor warrants and represents that all Deliverables sold the City under the Contract shall be free from defects in design, workmanship or manufacture, and conform in all material respects to the specifications, drawings, and descriptions in the Solicitation, to any samples furnished by the Contractor, to the terms, covenants and conditions of the Contract, and to all applicable State, Federal or local laws, rules, and regulations, and industry codes and standards. Unless otherwise stated in the Solicitation, the Deliverables shall be new or recycled merchandise, and not used or reconditioned.
- A. Recycled Deliverables shall be clearly identified as such.
 - B. The Contractor may not limit, exclude or disclaim the foregoing warranty or any warranty implied by law; and any attempt to do so shall be without force or effect.
 - C. Unless otherwise specified in the Contract, the warranty period shall be at least one year from the date of acceptance of the Deliverables or from the date of acceptance of any replacement Deliverables. If during the warranty period, one or more of the above warranties are breached, the Contractor shall promptly upon receipt of demand either repair the non-conforming Deliverables, or replace the non-conforming Deliverables with fully conforming Deliverables, at the City's option and at no additional cost to the City. All costs incidental to such repair or replacement, including but not limited to, any packaging and shipping costs, shall be borne exclusively by the Contractor. The City shall endeavor to give the Contractor written notice of the breach of warranty within thirty (30) calendar days of discovery of the breach of warranty, but failure to give timely notice shall not impair the City's rights under this section.
 - D. If the Contractor is unable or unwilling to repair or replace defective or non-conforming Deliverables as required by the City, then in addition to any other available remedy, the City may reduce the quantity of Deliverables it may be required to purchase under the Contract from the Contractor, and purchase conforming Deliverables from other sources. In such event, the Contractor shall pay to the City upon demand the increased cost, if any, incurred by the City to procure such Deliverables from another source.
 - E. If the Contractor is not the manufacturer, and the Deliverables are covered by a separate manufacturer's warranty, the Contractor shall transfer and assign such manufacturer's warranty to the City. If for any reason the manufacturer's warranty cannot be fully transferred to the City, the Contractor shall assist and cooperate with the City to the fullest extent to enforce such manufacturer's warranty for the benefit of the City.
22. **WARRANTY – SERVICES:** The Contractor warrants and represents that all services to be provided the City under the Contract will be fully and timely performed in a good and workmanlike manner in accordance with generally accepted industry standards and practices, the terms, conditions, and covenants of the Contract, and all applicable Federal, State and local laws, rules or regulations.
- A. The Contractor may not limit, exclude or disclaim the foregoing warranty or any warranty implied by law, and any attempt to do so shall be without force or effect.
 - B. Unless otherwise specified in the Contract, the warranty period shall be at least one year from the Acceptance Date. If during the warranty period, one or more of the above warranties are breached, the Contractor shall promptly upon receipt of demand perform the services again in accordance with above standard at no additional cost to the City. All costs incidental to such additional performance shall be borne by the Contractor. The City shall endeavor to give the Contractor written notice of the breach of warranty within thirty (30) calendar days of discovery of the breach warranty, but failure to give timely notice shall not impair the City's rights under this section.
 - C. If the Contractor is unable or unwilling to perform its services in accordance with the above standard as required by the City, then in addition to any other available remedy, the City may reduce the amount of services it may be

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required to purchase under the Contract from the Contractor, and purchase conforming services from other sources. In such event, the Contractor shall pay to the City upon demand the increased cost, if any, incurred by the City to procure such services from another source.

23. **ACCEPTANCE OF INCOMPLETE OR NON-CONFORMING DELIVERABLES:** If, instead of requiring immediate correction or removal and replacement of defective or non-conforming Deliverables, the City prefers to accept it, the City may do so. The Contractor shall pay all claims, costs, losses and damages attributable to the City's evaluation of and determination to accept such defective or non-conforming Deliverables. If any such acceptance occurs prior to final payment, the City may deduct such amounts as are necessary to compensate the City for the diminished value of the defective or non-conforming Deliverables. If the acceptance occurs after final payment, such amount will be refunded to the City by the Contractor.
24. **RIGHT TO ASSURANCE:** Whenever one party to the Contract in good faith has reason to question the other party's intent to perform, demand may be made to the other party for written assurance of the intent to perform. In the event that no assurance is given within the time specified after demand is made, the demanding party may treat this failure as an anticipatory repudiation of the Contract.
25. **STOP WORK NOTICE:** The City may issue an immediate Stop Work Notice in the event the Contractor is observed performing in a manner that is in violation of Federal, State, or local guidelines, or in a manner that is determined by the City to be unsafe to either life or property. Upon notification, the Contractor will cease all work until notified by the City that the violation or unsafe condition has been corrected. The Contractor shall be liable for all costs incurred by the City as a result of the issuance of such Stop Work Notice.
26. **DEFAULT:** The Contractor shall be in default under the Contract if the Contractor (a) fails to fully, timely and faithfully perform any of its material obligations under the Contract, (b) fails to provide adequate assurance of performance under Paragraph 24, (c) becomes insolvent or seeks relief under the bankruptcy laws of the United States or (d) makes a material misrepresentation in Contractor's Offer, or in any report or deliverable required to be submitted by the Contractor to the City.
27. **TERMINATION FOR CAUSE:** In the event of a default by the Contractor, the City shall have the right to terminate the Contract for cause, by written notice effective ten (10) calendar days, unless otherwise specified, after the date of such notice, unless the Contractor, within such ten (10) day period, cures such default, or provides evidence sufficient to prove to the City's reasonable satisfaction that such default does not, in fact, exist. The City may place Contractor on probation for a specified period of time within which the Contractor must correct any non-compliance issues. Probation shall not normally be for a period of more than nine (9) months, however, it may be for a longer period, not to exceed one (1) year depending on the circumstances. If the City determines the Contractor has failed to perform satisfactorily during the probation period, the City may proceed with suspension. In the event of a default by the Contractor, the City may suspend or debar the Contractor in accordance with the "City of Austin Purchasing Office Probation, Suspension and Debarment Rules for Vendors" and remove the Contractor from the City's vendor list for up to five (5) years and any Offer submitted by the Contractor may be disqualified for up to five (5) years. In addition to any other remedy available under law or in equity, the City shall be entitled to recover all actual damages, costs, losses and expenses, incurred by the City as a result of the Contractor's default, including, without limitation, cost of cover, reasonable attorneys' fees, court costs, and prejudgment and post-judgment interest at the maximum lawful rate. All rights and remedies under the Contract are cumulative and are not exclusive of any other right or remedy provided by law.
28. **TERMINATION WITHOUT CAUSE:** The City shall have the right to terminate the Contract, in whole or in part, without cause any time upon thirty (30) calendar days' prior written notice. Upon receipt of a notice of termination, the Contractor shall promptly cease all further work pursuant to the Contract, with such exceptions, if any, specified in the notice of termination. The City shall pay the Contractor, to the extent of funds Appropriated or otherwise legally available for such purposes, for all goods delivered and services performed and obligations incurred prior to the date of termination in accordance with the terms hereof.
29. **FRAUD:** Fraudulent statements by the Contractor on any Offer or in any report or deliverable required to be submitted by the Contractor to the City shall be grounds for the termination of the Contract for cause by the City and may result in legal action.

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30. DELAYS:

- A. The City may delay scheduled delivery or other due dates by written notice to the Contractor if the City deems it is in its best interest. If such delay causes an increase in the cost of the work under the Contract, the City and the Contractor shall negotiate an equitable adjustment for costs incurred by the Contractor in the Contract price and execute an amendment to the Contract. The Contractor must assert its right to an adjustment within thirty (30) calendar days from the date of receipt of the notice of delay. Failure to agree on any adjusted price shall be handled under the Dispute Resolution process specified in paragraph 48. However, nothing in this provision shall excuse the Contractor from delaying the delivery as notified.
- B. Neither party shall be liable for any default or delay in the performance of its obligations under this Contract if, while and to the extent such default or delay is caused by acts of God, fire, riots, civil commotion, labor disruptions, sabotage, sovereign conduct, or any other cause beyond the reasonable control of such Party. In the event of default or delay in contract performance due to any of the foregoing causes, then the time for completion of the services will be extended; provided, however, in such an event, a conference will be held within three (3) business days to establish a mutually agreeable period of time reasonably necessary to overcome the effect of such failure to perform.

31. INDEMNITY:

- A. Definitions:
 - i. "Indemnified Claims" shall include any and all claims, demands, suits, causes of action, judgments and liability of every character, type or description, including all reasonable costs and expenses of litigation, mediation or other alternate dispute resolution mechanism, including attorney and other professional fees for:
 - (1) damage to or loss of the property of any person (including, but not limited to the City, the Contractor, their respective agents, officers, employees and subcontractors; the officers, agents, and employees of such subcontractors; and third parties); and/or
 - (2) death, bodily injury, illness, disease, worker's compensation, loss of services, or loss of income or wages to any person (including but not limited to the agents, officers and employees of the City, the Contractor, the Contractor's subcontractors, and third parties),
 - ii. "Fault" shall include the sale of defective or non-conforming Deliverables, negligence, willful misconduct, or a breach of any legally imposed strict liability standard.
- B. **THE CONTRACTOR SHALL DEFEND (AT THE OPTION OF THE CITY), INDEMNIFY, AND HOLD THE CITY, ITS SUCCESSORS, ASSIGNS, OFFICERS, EMPLOYEES AND ELECTED OFFICIALS HARMLESS FROM AND AGAINST ALL INDEMNIFIED CLAIMS DIRECTLY ARISING OUT OF, INCIDENT TO, CONCERNING OR RESULTING FROM THE FAULT OF THE CONTRACTOR, OR THE CONTRACTOR'S AGENTS, EMPLOYEES OR SUBCONTRACTORS, IN THE PERFORMANCE OF THE CONTRACTOR'S OBLIGATIONS UNDER THE CONTRACT. NOTHING HEREIN SHALL BE DEEMED TO LIMIT THE RIGHTS OF THE CITY OR THE CONTRACTOR (INCLUDING, BUT NOT LIMITED TO, THE RIGHT TO SEEK CONTRIBUTION) AGAINST ANY THIRD PARTY WHO MAY BE LIABLE FOR AN INDEMNIFIED CLAIM.**

32. INSURANCE: (reference Section 0400 for specific coverage requirements). The following insurance requirement applies. (Revised March 2013).

- A. General Requirements.
 - i. The Contractor shall at a minimum carry insurance in the types and amounts indicated in Section 0400, Supplemental Purchase Provisions, for the duration of the Contract, including extension options and hold over periods, and during any warranty period.
 - ii. The Contractor shall provide Certificates of Insurance with the coverages and endorsements required in Section 0400, Supplemental Purchase Provisions, to the City as verification of coverage prior to contract execution and within fourteen (14) calendar days after written request from the

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City. Failure to provide the required Certificate of Insurance may subject the Offer to disqualification from consideration for award. The Contractor must also forward a Certificate of Insurance to the City whenever a previously identified policy period has expired, or an extension option or hold over period is exercised, as verification of continuing coverage.

- iii. The Contractor shall not commence work until the required insurance is obtained and until such insurance has been reviewed by the City. Approval of insurance by the City shall not relieve or decrease the liability of the Contractor hereunder and shall not be construed to be a limitation of liability on the part of the Contractor.
- iv. The City may request that the Contractor submit certificates of insurance to the City for all subcontractors prior to the subcontractors commencing work on the project.
- v. The Contractor's and all subcontractors' insurance coverage shall be written by companies licensed to do business in the State of Texas at the time the policies are issued and shall be written by companies with A.M. Best ratings of B+VII or better.
- vi. The "other" insurance clause shall not apply to the City where the City is an additional insured shown on any policy. It is intended that policies required in the Contract, covering both the City and the Contractor, shall be considered primary coverage as applicable.
- vii. If insurance policies are not written for amounts specified in Section 0400, Supplemental Purchase Provisions, the Contractor shall carry Umbrella or Excess Liability Insurance for any differences in amounts specified. If Excess Liability Insurance is provided, it shall follow the form of the primary coverage.
- viii. The City shall be entitled, upon request, at an agreed upon location, and without expense, to review certified copies of policies and endorsements thereto and may make any reasonable requests for deletion or revision or modification of particular policy terms, conditions, limitations, or exclusions except where policy provisions are established by law or regulations binding upon either of the parties hereto or the underwriter on any such policies.
- ix. The City reserves the right to review the insurance requirements set forth during the effective period of the Contract and to make reasonable adjustments to insurance coverage, limits, and exclusions when deemed necessary and prudent by the City based upon changes in statutory law, court decisions, the claims history of the industry or financial condition of the insurance company as well as the Contractor.
- x. The Contractor shall not cause any insurance to be canceled nor permit any insurance to lapse during the term of the Contract or as required in the Contract.
- xi. The Contractor shall be responsible for premiums, deductibles and self-insured retentions, if any, stated in policies. Self-insured retentions shall be disclosed on the Certificate of Insurance.
- xii. The Contractor shall provide the City thirty (30) calendar days' written notice of erosion of the aggregate limits below occurrence limits for all applicable coverages indicated within the Contract.
- xiii. The insurance coverages specified in Section 0400, Supplemental Purchase Provisions, are required minimums and are not intended to limit the responsibility or liability of the Contractor.

B. Specific Coverage Requirements: Specific insurance requirements are contained in Section 0400, Supplemental Purchase Provisions

33. **CLAIMS:** If any claim, demand, suit, or other action is asserted against the Contractor which arises under or concerns the Contract, or which could have a material adverse affect on the Contractor's ability to perform thereunder, the Contractor shall give written notice thereof to the City within ten (10) calendar days after receipt of notice by the

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Contractor. Such notice to the City shall state the date of notification of any such claim, demand, suit, or other action; the names and addresses of the claimant(s); the basis thereof; and the name of each person against whom such claim is being asserted. Such notice shall be delivered personally or by mail and shall be sent to the City and to the Austin City Attorney. Personal delivery to the City Attorney shall be to City Hall, 301 West 2nd Street, 4th Floor, Austin, Texas 78701, and mail delivery shall be to P.O. Box 1088, Austin, Texas 78767.

34. **NOTICES**: Unless otherwise specified, all notices, requests, or other communications required or appropriate to be given under the Contract shall be in writing and shall be deemed delivered three (3) business days after postmarked if sent by U.S. Postal Service Certified or Registered Mail, Return Receipt Requested. Notices delivered by other means shall be deemed delivered upon receipt by the addressee. Routine communications may be made by first class mail, telefax, or other commercially accepted means. Notices to the Contractor shall be sent to the address specified in the Contractor's Offer, or at such other address as a party may notify the other in writing. Notices to the City shall be addressed to the City at P.O. Box 1088, Austin, Texas 78767 and marked to the attention of the Contract Administrator.
35. **RIGHTS TO BID, PROPOSAL AND CONTRACTUAL MATERIAL**: All material submitted by the Contractor to the City shall become property of the City upon receipt. Any portions of such material claimed by the Contractor to be proprietary must be clearly marked as such. Determination of the public nature of the material is subject to the Texas Public Information Act, Chapter 552, Texas Government Code.
36. **NO WARRANTY BY CITY AGAINST INFRINGEMENTS**: The Contractor represents and warrants to the City that: (i) the Contractor shall provide the City good and indefeasible title to the Deliverables and (ii) the Deliverables supplied by the Contractor in accordance with the specifications in the Contract will not infringe, directly or contributorily, any patent, trademark, copyright, trade secret, or any other intellectual property right of any kind of any third party; that no claims have been made by any person or entity with respect to the ownership or operation of the Deliverables and the Contractor does not know of any valid basis for any such claims. The Contractor shall, at its sole expense, defend, indemnify, and hold the City harmless from and against all liability, damages, and costs (including court costs and reasonable fees of attorneys and other professionals) arising out of or resulting from: (i) any claim that the City's exercise anywhere in the world of the rights associated with the City's ownership, and if applicable, license rights, and its use of the Deliverables infringes the intellectual property rights of any third party; or (ii) the Contractor's breach of any of Contractor's representations or warranties stated in this Contract. In the event of any such claim, the City shall have the right to monitor such claim or at its option engage its own separate counsel to act as co-counsel on the City's behalf. Further, Contractor agrees that the City's specifications regarding the Deliverables shall in no way diminish Contractor's warranties or obligations under this paragraph and the City makes no warranty that the production, development, or delivery of such Deliverables will not impact such warranties of Contractor.
37. **CONFIDENTIALITY**: In order to provide the Deliverables to the City, Contractor may require access to certain of the City's and/or its licensors' confidential information (including inventions, employee information, trade secrets, confidential know-how, confidential business information, and other information which the City or its licensors consider confidential) (collectively, "Confidential Information"). Contractor acknowledges and agrees that the Confidential Information is the valuable property of the City and/or its licensors and any unauthorized use, disclosure, dissemination, or other release of the Confidential Information will substantially injure the City and/or its licensors. The Contractor (including its employees, subcontractors, agents, or representatives) agrees that it will maintain the Confidential Information in strict confidence and shall not disclose, disseminate, copy, divulge, recreate, or otherwise use the Confidential Information without the prior written consent of the City or in a manner not expressly permitted under this Agreement, unless the Confidential Information is required to be disclosed by law or an order of any court or other governmental authority with proper jurisdiction, provided the Contractor promptly notifies the City before disclosing such information so as to permit the City reasonable time to seek an appropriate protective order. The Contractor agrees to use protective measures no less stringent than the Contractor uses within its own business to protect its own most valuable information, which protective measures shall under all circumstances be at least reasonable measures to ensure the continued confidentiality of the Confidential Information.
38. **PUBLICATIONS**: All published material and written reports submitted under the Contract must be originally developed material unless otherwise specifically provided in the Contract. When material not originally developed is included in a report in any form, the source shall be identified.

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39. **ADVERTISING**: The Contractor shall not advertise or publish, without the City's prior consent, the fact that the City has entered into the Contract, except to the extent required by law.
40. **NO CONTINGENT FEES**: The Contractor warrants that no person or selling agency has been employed or retained to solicit or secure the Contract upon any agreement or understanding for commission, percentage, brokerage, or contingent fee, excepting bona fide employees of bona fide established commercial or selling agencies maintained by the Contractor for the purpose of securing business. For breach or violation of this warranty, the City shall have the right, in addition to any other remedy available, to cancel the Contract without liability and to deduct from any amounts owed to the Contractor, or otherwise recover, the full amount of such commission, percentage, brokerage or contingent fee.
41. **GRATUITIES**: The City may, by written notice to the Contractor, cancel the Contract without liability if it is determined by the City that gratuities were offered or given by the Contractor or any agent or representative of the Contractor to any officer or employee of the City of Austin with a view toward securing the Contract or securing favorable treatment with respect to the awarding or amending or the making of any determinations with respect to the performing of such contract. In the event the Contract is canceled by the City pursuant to this provision, the City shall be entitled, in addition to any other rights and remedies, to recover or withhold the amount of the cost incurred by the Contractor in providing such gratuities.
42. **PROHIBITION AGAINST PERSONAL INTEREST IN CONTRACTS**: No officer, employee, independent consultant, or elected official of the City who is involved in the development, evaluation, or decision-making process of the performance of any solicitation shall have a financial interest, direct or indirect, in the Contract resulting from that solicitation. Any willful violation of this section shall constitute impropriety in office, and any officer or employee guilty thereof shall be subject to disciplinary action up to and including dismissal. Any violation of this provision, with the knowledge, expressed or implied, of the Contractor shall render the Contract voidable by the City.
43. **INDEPENDENT CONTRACTOR**: The Contract shall not be construed as creating an employer/employee relationship, a partnership, or a joint venture. The Contractor's services shall be those of an independent contractor. The Contractor agrees and understands that the Contract does not grant any rights or privileges established for employees of the City.
44. **ASSIGNMENT-DELEGATION**: The Contract shall be binding upon and enure to the benefit of the City and the Contractor and their respective successors and assigns, provided however, that no right or interest in the Contract shall be assigned and no obligation shall be delegated by the Contractor without the prior written consent of the City. Any attempted assignment or delegation by the Contractor shall be void unless made in conformity with this paragraph. The Contract is not intended to confer rights or benefits on any person, firm or entity not a party hereto; it being the intention of the parties that there be no third party beneficiaries to the Contract.
45. **WAIVER**: No claim or right arising out of a breach of the Contract can be discharged in whole or in part by a waiver or renunciation of the claim or right unless the waiver or renunciation is supported by consideration and is in writing signed by the aggrieved party. No waiver by either the Contractor or the City of any one or more events of default by the other party shall operate as, or be construed to be, a permanent waiver of any rights or obligations under the Contract, or an express or implied acceptance of any other existing or future default or defaults, whether of a similar or different character.
46. **MODIFICATIONS**: The Contract can be modified or amended only by a writing signed by both parties. No pre-printed or similar terms on any the Contractor invoice, order or other document shall have any force or effect to change the terms, covenants, and conditions of the Contract.
47. **INTERPRETATION**: The Contract is intended by the parties as a final, complete and exclusive statement of the terms of their agreement. No course of prior dealing between the parties or course of performance or usage of the trade shall be relevant to supplement or explain any term used in the Contract. Although the Contract may have been substantially drafted by one party, it is the intent of the parties that all provisions be construed in a manner to be fair to both parties, reading no provisions more strictly against one party or the other. Whenever a term defined by the Uniform Commercial Code, as enacted by the State of Texas, is used in the Contract, the UCC definition shall control, unless otherwise defined in the Contract.

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48. DISPUTE RESOLUTION:

- A. If a dispute arises out of or relates to the Contract, or the breach thereof, the parties agree to negotiate prior to prosecuting a suit for damages. However, this section does not prohibit the filing of a lawsuit to toll the running of a statute of limitations or to seek injunctive relief. Either party may make a written request for a meeting between representatives of each party within fourteen (14) calendar days after receipt of the request or such later period as agreed by the parties. Each party shall include, at a minimum, one (1) senior level individual with decision-making authority regarding the dispute. The purpose of this and any subsequent meeting is to attempt in good faith to negotiate a resolution of the dispute. If, within thirty (30) calendar days after such meeting, the parties have not succeeded in negotiating a resolution of the dispute, they will proceed directly to mediation as described below. Negotiation may be waived by a written agreement signed by both parties, in which event the parties may proceed directly to mediation as described below.
- B. If the efforts to resolve the dispute through negotiation fail, or the parties waive the negotiation process, the parties may select, within thirty (30) calendar days, a mediator trained in mediation skills to assist with resolution of the dispute. Should they choose this option, the City and the Contractor agree to act in good faith in the selection of the mediator and to give consideration to qualified individuals nominated to act as mediator. Nothing in the Contract prevents the parties from relying on the skills of a person who is trained in the subject matter of the dispute or a contract interpretation expert. If the parties fail to agree on a mediator within thirty (30) calendar days of initiation of the mediation process, the mediator shall be selected by the Travis County Dispute Resolution Center (DRC). The parties agree to participate in mediation in good faith for up to thirty (30) calendar days from the date of the first mediation session. The City and the Contractor will share the mediator's fees equally and the parties will bear their own costs of participation such as fees for any consultants or attorneys they may utilize to represent them or otherwise assist them in the mediation.

49. **JURISDICTION AND VENUE:** The Contract is made under and shall be governed by the laws of the State of Texas, including, when applicable, the Uniform Commercial Code as adopted in Texas, V.T.C.A., Bus. & Comm. Code, Chapter 1, excluding any rule or principle that would refer to and apply the substantive law of another state or jurisdiction. All issues arising from this Contract shall be resolved in the courts of Travis County, Texas and the parties agree to submit to the exclusive personal jurisdiction of such courts. The foregoing, however, shall not be construed or interpreted to limit or restrict the right or ability of the City to seek and secure injunctive relief from any competent authority as contemplated herein.

50. **INVALIDITY:** The invalidity, illegality, or unenforceability of any provision of the Contract shall in no way affect the validity or enforceability of any other portion or provision of the Contract. Any void provision shall be deemed severed from the Contract and the balance of the Contract shall be construed and enforced as if the Contract did not contain the particular portion or provision held to be void. The parties further agree to reform the Contract to replace any stricken provision with a valid provision that comes as close as possible to the intent of the stricken provision. The provisions of this section shall not prevent this entire Contract from being void should a provision which is the essence of the Contract be determined to be void.

51. **HOLIDAYS:** The following holidays are observed by the City:

<u>Holiday</u>	<u>Date Observed</u>
New Year's Day	January 1
Martin Luther King, Jr.'s Birthday	Third Monday in January
President's Day	Third Monday in February
Memorial Day	Last Monday in May
Independence Day	July 4
Labor Day	First Monday in September
Veteran's Day	November 11

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Thanksgiving Day	Fourth Thursday in November
Friday after Thanksgiving	Friday after Thanksgiving
Christmas Eve	December 24
Christmas Day	December 25

If a Legal Holiday falls on Saturday, it will be observed on the preceding Friday. If a Legal Holiday falls on Sunday, it will be observed on the following Monday.

52. **SURVIVABILITY OF OBLIGATIONS:** All provisions of the Contract that impose continuing obligations on the parties, including but not limited to the warranty, indemnity, and confidentiality obligations of the parties, shall survive the expiration or termination of the Contract.

53. **NON-SUSPENSION OR DEBARMENT CERTIFICATION:**

The City of Austin is prohibited from contracting with or making prime or sub-awards to parties that are suspended or debarred or whose principals are suspended or debarred from Federal, State, or City of Austin Contracts. By accepting a Contract with the City, the Vendor certifies that its firm and its principals are not currently suspended or debarred from doing business with the Federal Government, as indicated by the General Services Administration List of Parties Excluded from Federal Procurement and Non-Procurement Programs, the State of Texas, or the City of Austin.

54. **EQUAL OPPORTUNITY**

- A. **Equal Employment Opportunity:** No Contractor, or Contractor's agent, shall engage in any discriminatory employment practice as defined in Chapter 5-4 of the City Code. No Offer submitted to the City shall be considered, nor any Purchase Order issued, or any Contract awarded by the City unless the Offeror has executed and filed with the City Purchasing Office a current Non-Discrimination Certification. Non-compliance with Chapter 5-4 of the City Code may result in sanctions, including termination of the contract and the Contractor's suspension or debarment from participation on future City contracts until deemed compliant with Chapter 5-4.
- B. **Americans with Disabilities Act (ADA) Compliance:** No Contractor, or Contractor's agent, shall engage in any discriminatory practice against individuals with disabilities as defined in the ADA, including but not limited to: employment, accessibility to goods and services, reasonable accommodations, and effective communications.

55. **BUY AMERICAN ACT-SUPPLIES (Applicable to certain Federally funded requirements)**

- A. Definitions. As used in this paragraph –
- i. "Component" means an article, material, or supply incorporated directly into an end product.
 - ii. "Cost of components" means -
 - (1) For components purchased by the Contractor, the acquisition cost, including transportation costs to the place of incorporation into the end product (whether or not such costs are paid to a domestic firm), and any applicable duty (whether or not a duty-free entry certificate is issued); or
 - (2) For components manufactured by the Contractor, all costs associated with the manufacture of the component, including transportation costs as described in paragraph (1) of this definition, plus allocable overhead costs, but excluding profit. Cost of components does not include any costs associated with the manufacture of the end product.

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- iii. "Domestic end product" means-
 - (1) An unmanufactured end product mined or produced in the United States; or
 - (2) An end product manufactured in the United States, if the cost of its components mined, produced, or manufactured in the United States exceeds 50 percent of the cost of all its components. Components of foreign origin of the same class or kind as those that the agency determines are not mined, produced, or manufactured in sufficient and reasonably available commercial quantities of a satisfactory quality are treated as domestic. Scrap generated, collected, and prepared for processing in the United States is considered domestic.
- iv. "End product" means those articles, materials, and supplies to be acquired under the contract for public use.
- v. "Foreign end product" means an end product other than a domestic end product.
- vi. "United States" means the 50 States, the District of Columbia, and outlying areas.
- B. The Buy American Act (41 U.S.C. 10a - 10d) provides a preference for domestic end products for supplies acquired for use in the United States.
- C. The City does not maintain a list of foreign articles that will be treated as domestic for this Contract; but will consider for approval foreign articles as domestic for this product if the articles are on a list approved by another Governmental Agency. The Offeror shall submit documentation with their Offer demonstrating that the article is on an approved Governmental list.
- D. The Contractor shall deliver only domestic end products except to the extent that it specified delivery of foreign end products in the provision of the Solicitation entitled "Buy American Act Certificate".

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SUPPLEMENTAL PURCHASE PROVISIONS**

The following Supplemental Purchasing Provisions apply to this solicitation:

1. **EXPLANATIONS OR CLARIFICATIONS:** (reference paragraph 5 in Section 0200)

All requests for explanations or clarifications must be submitted in writing to the Purchasing Office by writing to Michelle.Pearson@austintexas.gov at least five (5) business days before solicitation due date.

2. **INSURANCE:** Insurance is required for this solicitation.

A. **General Requirements:** See Section 0300, Standard Purchase Terms and Conditions, paragraph 32, entitled Insurance, for general insurance requirements.

- i. The Contractor shall provide a Certificate of Insurance as verification of coverages required below to the City at the below address prior to contract execution and within 14 calendar days after written request from the City. Failure to provide the required Certificate of Insurance may subject the Offer to disqualification from consideration for award
- ii. The Contractor shall not commence work until the required insurance is obtained and until such insurance has been reviewed by the City. Approval of insurance by the City shall not relieve or decrease the liability of the Contractor hereunder and shall not be construed to be a limitation of liability on the part of the Contractor.
- iii. The Contractor must also forward a Certificate of Insurance to the City whenever a previously identified policy period has expired, or an extension option or holdover period is exercised, as verification of continuing coverage.
- iv. The Certificate of Insurance, and updates, shall be mailed to the following address:

City of Austin Purchasing Office
P. O. Box 1088
Austin, Texas 78767

OR

PURInsuranceCompliance@austintexas.gov

B. **Specific Coverage Requirements:** The Contractor shall at a minimum carry insurance in the types and amounts indicated below for the duration of the Contract, including extension options and hold over periods, and during any warranty period. These insurance coverages are required minimums and are not intended to limit the responsibility or liability of the Contractor.

- i. **Worker's Compensation and Employers' Liability Insurance:** Coverage shall be consistent with statutory benefits outlined in the Texas Worker's Compensation Act (Section 401). The minimum policy limits for Employer's Liability are \$100,000 bodily injury each accident, \$500,000 bodily injury by disease policy limit and \$100,000 bodily injury by disease each employee.
 - (1) The Contractor's policy shall apply to the State of Texas and include these endorsements in favor of the City of Austin:
 - (a) Waiver of Subrogation, Form WC420304, or equivalent coverage
 - (b) Thirty (30) days Notice of Cancellation, Form WC420601, or equivalent coverage
- ii. **Commercial General Liability Insurance:** The minimum bodily injury and property damage per occurrence are \$500,000 for coverages A (Bodily Injury and Property Damage) and B (Personal and Advertising Injury).
 - (1) The policy shall contain the following provisions:
 - (a) Contractual liability coverage for liability assumed under the Contract and all other Contracts related to the project.
 - (b) Contractor/Subcontracted Work.
 - (c) Products/Completed Operations Liability for the duration of the warranty period.

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- (d) If the project involves digging or drilling provisions must be included that provide Explosion, Collapse, and/or Underground Coverage.
 - (2) The policy shall also include these endorsements in favor of the City of Austin:
 - (a) Waiver of Subrogation, Endorsement CG 2404, or equivalent coverage
 - (b) Thirty (30) days Notice of Cancellation, Endorsement CG 0205, or equivalent coverage
 - (c) The City of Austin listed as an additional insured, Endorsement CG 2010, or equivalent coverage
 - iii. **Business Automobile Liability Insurance:** The Contractor shall provide coverage for all owned, non-owned and hired vehicles with a minimum combined single limit of \$500,000 per occurrence for bodily injury and property damage. Alternate acceptable limits are \$250,000 bodily injury per person, \$500,000 bodily injury per occurrence and at least \$100,000 property damage liability per accident.
 - (1) The policy shall include these endorsements in favor of the City of Austin:
 - (a) Waiver of Subrogation, Endorsement CA0444, or equivalent coverage
 - (b) Thirty (30) days Notice of Cancellation, Endorsement CA0244, or equivalent coverage
 - (c) The City of Austin listed as an additional insured, Endorsement CA2048, or equivalent coverage.
- C. **Endorsements:** The specific insurance coverage endorsements specified above, or their equivalents must be provided. In the event that endorsements, which are the equivalent of the required coverage, are proposed to be substituted for the required coverage, copies of the equivalent endorsements must be provided for the City's review and approval.
3. **TERM OF CONTRACT:**
- A. The Contract shall commence upon execution, unless otherwise specified, and shall remain in effect for an initial term of twenty-four (24) months. The Contract may be extended beyond the initial term for up to three (3) additional twelve (12) month periods at the City's sole option. If the City exercises any extension option, all terms, conditions, and provisions of the Contract shall remain in effect for that extension period, subject only to any economic price adjustment otherwise allowed under the Contract.
 - B. Upon expiration of the initial term or any period of extension, the Contractor agrees to hold over under the terms and conditions of this Contract for such a period of time as is reasonably necessary for the City to re-solicit and/or complete the deliverables due under this Contract. Any hold over period will not exceed 120 calendar days unless mutually agreed on by both parties in writing.
 - C. Upon written notice to the Contractor from the City's Purchasing Officer or his designee and acceptance of the Contractor, the term of this contract shall be extended on the same terms and conditions for an additional period as indicated in paragraph A above.
 - D. Prices are firm and fixed for the first twelve (12) months. Thereafter, price changes are subject to the Economic Price Adjustment provisions of this Contract.
4. **QUANTITIES:** The quantities listed herein are estimates for the period of the Contract. The City reserves the right to purchase more or less of these quantities as may be required during the Contract term. Quantities will be as needed and specified by the City for each order. Unless specified in the solicitation, there are no minimum order quantities.
5. **DELIVERY REQUIREMENTS:**

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Location:

Days:

Austin Transportation Dept.

Monday – Friday 8:30 AM – 2:00 PM

7211 Interstate Highway 35 North, Austin, TX
78752

- A. Delivery shall be made within 25 working days after the order is placed (either verbally or in writing). All orders must be shipped complete unless arrangements for partial shipments are made in advance.
- B. The Contractor shall provide with each delivery a Shipping or Delivery Ticket showing the description of each item, quantity, and unit price.
- C. The Contractor shall confirm the quantity to be shipped on all orders within two (2) hours of notification by phone from the City.
- D. The Traffic Signal Supervisor shall be notified twenty-four (24) hours in advance of any scheduled delivery at 512-921-1315 or 512-203-4223 as arrangements must be made to have City staff available to unload shipments. The delivery driver shall call the Traffic Signal Supervisor one (1) hour in advance of arriving at the 7211 Interstate Highway 35 North location at 512-921-1315 or 512-203-4223. Failure of the driver to call the Traffic Signal Supervisor one (1) hour in advance of arrival may result in the delivery being delayed or rejected.
- E. Unless requested by the City, deliveries shall not be made on City-recognized legal holidays (see paragraph 51 in Section 0300) or outside of the hours listed above.
- F. The manufacturer/provider shall submit a certification document with each lot or shipment stating that the LED traffic signal lamp and/or bicycle lamp units being provided meet or exceed all the requirements of this specification. The certification document shall show individual lot numbers and manufacturer dates.
- G. The following documentation shall be submitted upon delivery of goods:
 - i. Each LED traffic signal lamp and bicycle lamp shall be provided with the following documentation:
 - (1) Complete and accurate installation wiring guide.
 - (2) Contact name, address, telephone number and email address or webpage for the representative, manufacturer, or distributor for warranty replacement.
 - (3) Schematics for all electronics.
 - ii. Manufacturers International Organization for Standards (ISO) 9000 certification or latest revision.

6. **INVOICES and PAYMENT:** (reference paragraphs 12 and 13 in Section 0300)

- A. Invoices shall contain a unique invoice number and the information required in Section 0300, paragraph 12, entitled "Invoices." Invoices received without all required information cannot be processed and will be returned to the vendor.

Invoices shall be mailed to the below address:

	City of Austin
Department	Public Works – Support Services/Construction Services

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Attn:	Accounts Payable
Address	505 Barton Springs Rd. Ste. 1000
City, State Zip Code	Austin, TX 78704

- B. The Contractor agrees to accept payment by either credit card, check or Electronic Funds Transfer (EFT) for all goods and/or services provided under the Contract. The Contractor shall factor the cost of processing credit card payments into the Offer. There shall be no additional charges, surcharges, or penalties to the City for payments made by credit card.

7. MATERIALS SPECIFICATIONS/DESCRIPTIVE LITERATURE:

- A. If a solicitation refers to a Qualified Products List (QPL), Standard Products List (SPL) or a manufacturer's name and product, any Offeror offering products not referenced in the solicitation must submit as part of their Offer materials specifications/descriptive literature for the non-referenced product. Materials specifications/descriptive literature must be identified to show the item(s) in the Offer to which it applies.
- B. Materials specifications/descriptive literature are defined as product manufacturer's catalog pages, "cut sheets" applicable tests results, or related detailed documents that specify material construction, performance parameters, and any industrial standards that are applicable such as ANSI, ASTM, ASME, SAE, NFPA, NBS, EIA, ESL, and NSA. The submitted materials specifications/descriptive literature must include the manufacturer's name and product number of the product being offered.
- C. The failure of the materials specifications/descriptive literature to show that the product offered conforms to the requirements of the Solicitation shall result in rejection of the Offer.
- D. Failure to submit the materials specifications/descriptive literature as part of the Offer may subject the Offer to disqualification from consideration for award.

8. SAMPLES – EXACT REPLICA:

- A. Once requested, the Offeror shall submit an exact replica of the goods to be provided per the specification. This sample shall be provided within five (5) working days after request by the City.
- B. Send samples to the City at the following address:

	City of Austin
Department	Austin Transportation Dept.
Address	1501 Toomey Road
City, State Zip Code	Austin, TX 78704

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Attn:	Signal Supervisor
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- C. All products provided to the City under this solicitation will be evaluated or tested and must meet all requirements of the specification, regardless of whether or not all requirements are to be evaluated or tested.
- D. Samples will be provided at no cost to the City, will be retained by the City and shall not be considered a part of any future purchases, and may be used for use in assuring compliance with materials specifications after award. Failure to supply samples when requested shall subject the Offer to disqualification from consideration for award.

9. NON-COLLUSION, NON-CONFLICT OF INTEREST, AND ANTI-LOBBYING:

- A. On November 10, 2011, the Austin City Council adopted Ordinance No. 20111110-052 amending Chapter 2.7, Article 6 of the City Code relating to Anti-Lobbying and Procurement. The policy defined in this Code applies to Solicitations for goods and/or services requiring City Council approval under City Charter Article VII, Section 15 (Purchase Procedures). During the No-Contact Period, Offerors or potential Offerors are prohibited from making a representation to anyone other than the Authorized Contact Person in the Solicitation as the contact for questions and comments regarding the Solicitation.
- B. If during the No-Contact Period an Offeror makes a representation to anyone other than the Authorized Contact Person for the Solicitation, the Offeror's Offer is disqualified from further consideration except as permitted in the Ordinance.
- C. If an Offeror has been disqualified under this article more than two times in a sixty (60) month period, the Purchasing Officer shall debar the Offeror from doing business with the City for a period not to exceed three (3) years, provided the Offeror is given written notice and a hearing in advance of the debarment.
- D. The City requires Offerors submitting Offers on this Solicitation to certify that the Offeror has not in any way directly or indirectly made representations to anyone other than the Authorized Contact Person during the No-Contact Period as defined in the Ordinance. The text of the City Ordinance is posted on the Internet at: <http://www.ci.austin.tx.us/edims/document.cfm?id=161145>

10. ECONOMIC PRICE ADJUSTMENT:

- A. **Price Adjustments:** Prices shown in this Contract shall remain firm for the first twelve (12) months of the Contract. After that, in recognition of the potential for fluctuation of the Contractor's cost, a price adjustment (increase or decrease) may be requested by either the City or the Contractor on the anniversary date of the Contract or as may otherwise be specified herein. The percentage change between the contract price and the requested price shall not exceed the percentage change between the specified index in effect on the date the solicitation closed and the most recent, non-preliminary data at the time the price adjustment is requested. The requested price adjustment shall not exceed ten (10) percent for any single line item and in no event shall the total amount of the contract be automatically adjusted as a result of the change in one or more line items made pursuant to this provision. Prices for products or services unaffected by verifiable cost trends shall not be subject to adjustment.
- B. **Effective Date:** Approved price adjustments will go into effect on the first day of the upcoming renewal period or anniversary date of contract award and remain in effect until contract expiration unless changed by subsequent amendment.
- C. **Adjustments:** A request for price adjustment must be made in writing and submitted to the other Party prior to the yearly anniversary date of the Contract; adjustments may only be considered at that

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time unless otherwise specified herein. Requested adjustments must be solely for the purpose of accommodating changes in the Contractor's direct costs. Contractor shall provide an updated price listing once agreed to adjustment(s) have been approved by the parties.

- D. **Indexes:** In most cases an index from the Bureau of Labor Standards (BLS) will be utilized; however, if there is more appropriate, industry recognized standard then that index may be selected.
- i. The following definitions apply:
- (1) **Base Period:** Month and year of the original contracted price (the solicitation close date).
 - (2) **Base Price:** Initial price quoted, proposed and/or contracted per unit of measure.
 - (3) **Adjusted Price:** Base Price after it has been adjusted in accordance with the applicable index change and instructions provided.
 - (4) **Change Factor:** The multiplier utilized to adjust the Base Price to the Adjusted Price.
 - (5) **Weight %:** The percent of the Base Price subject to adjustment based on an index change.
- ii. **Adjustment-Request Review:** Each adjustment-request received will be reviewed and compared to changes in the index(es) identified below. Where applicable:
- (1) Utilize final Compilation data instead of Preliminary data
 - (2) If the referenced index is no longer available shift up to the next higher category index.
- iii. **Index Identification:** Complete table as they may apply.

Weight % of Base Price: 100%	
Database Name: Producer Price Index	
Series ID: pcu3351--3351--	
<input checked="" type="checkbox"/> Not Seasonally Adjusted	<input type="checkbox"/> Seasonally Adjusted
Geographical Area: United States	
Description of Series ID: Electric lighting equipment mfg	
This Index shall apply to the following items of the Bid Sheet: All	

- E. **Calculation:** Price adjustment will be calculated as follows:

Single Index: Adjust the Base Price by the same factor calculated for the index change.

Index at time of calculation
Divided by index on solicitation close date
Equals Change Factor
Multiplied by the Base Rate
Equals the Adjusted Price

- F. If the requested adjustment is not supported by the referenced index, the City, at its sole discretion, may consider approving an adjustment on fully documented market increases.

11. **INTERLOCAL PURCHASING AGREEMENTS:** (applicable to competitively procured goods/services contracts).

- A. The City has entered into Interlocal Purchasing Agreements with other governmental entities,

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pursuant to the Interlocal Cooperation Act, Chapter 791 of the Texas Government Code. The Contractor agrees to offer the same prices and terms and conditions to other eligible governmental agencies that have an interlocal agreement with the City.

- B. The City does not accept any responsibility or liability for the purchases by other governmental agencies through an interlocal cooperative agreement.
12. **CONTRACT MANAGER:** The following person is designated as Contract Manager, and will act as the contact point between the City and the Contractor during the term of the Contract:

Ramona Aguilar

512-974-7050

Ramona.Aguilar@austintexas.gov

*Note: The above listed Contract Manager is not the authorized Contact Person for purposes of the **NON-COLLUSION, NON-CONFLICT OF INTEREST, AND ANTI-LOBBYING Provision** of this Section; and therefore, contact with the Contract Manager is prohibited during the no contact period.

Specifications
SOLICITATION NO. IFB 2400 MDP0263
Description: LED Traffic Signal Lamps

1.0 PURPOSE

This specification establishes the minimum requirements for the purchase of LED Incandescent Look Traffic Signal Lamps (Ball and Bi-Model indications, Left/Right and U-Turn Arrows) and Bicycle Signal Lamps.

This specification describes the minimum acceptable design and performance requirements for 12-inch (300 mm) light emitting diode (LED) circular, arrow, and bicycle traffic signal lamp units for span wire and mast arm applications. Only incandescent look LED's shall be considered for this bid which meet or exceed these specifications.

2.0 GENERAL REQUIREMENTS

- 2.1 All LED traffic signal lamps and bicycle signal lamps shall conform to the latest versions of the Institute of Transportation Engineers (I.T.E.) Vehicle Traffic Control Signal Heads (VTCSHs) LED Vehicle Arrow Traffic Signal Supplement standard, the I.T.E VTCSHs LED Circular Signal Supplement standard, and this specification. In the case of conflicts between standards and specifications, the latest City of Austin specifications shall govern.
- 2.2 The LED traffic signal lamps and bicycle signal lamps shall also be designed as a retrofit replacement for existing signal lamps which will not require any special tools for installation. The 12 inch (300 mm) retrofit /replacement LED traffic signal lamp unit shall fit into existing traffic signal housings without modifications.
- 2.3 When an LED traffic signal lamp and/or bicycle signal lamp is installed or replaced by the City in a new or existing signal housing, it shall only require removal of the existing lens and/or reflector and incandescent lamp and installing the new LED securely in the housing door, and connecting to existing electrical wiring or terminal block by means of simple connectors. No modifications to the signal housing or LED will be required for a proper dust proof and water-proof installation.
- 2.4 If proper orientation of the LED traffic signal lamp and bicycle signal lamp is required for optimum performance, prominent and permanent directional marking(s), that is an "UP arrow" or equivalent, for correct indexing and orientation shall exist on the unit.
- 2.5 The manufacturer's name, serial number, manufactured date (minimum week and year) and other necessary identification shall be permanently marked on the backside of the LED traffic signal lamp and bicycle signal lamps units. A label shall be placed on the unit certifying compliance to the latest I.T.E. VTCSHs LED Vehicle Arrow Traffic Signal Supplement or latest I.T.E. VTCSHs LED Circular Signal Supplement standards, including standard title and date.
- 2.6 The LED traffic signal lamp and bicycle signal lamp units shall be a single, self-contained device, not requiring assembly of any type for installation into new or existing traffic signal housings.
- 2.7 The assembly and manufacturing process for the LED traffic signal lamp and bicycle signal lamps unit shall be such as to ensure all internal LEDs and electronic components are adequately supported to withstand mechanical shock and vibration from high winds and other sources and be of a water tight design.
- 2.8 Each LED traffic signal lamp and bicycle signal lamp unit shall be comprised of a UV stabilized polymeric outer shell, multiple LED light sources, and a regulated power supply. LEDs are to be

mounted on a polycarbonate positioning plate or PC board. The inside of the lens shall be wiped clean of any moisture and dust prior to assembly. LEDs that appear to have a film on the inside of the lens shall be replaced by the manufacturer at no cost to the City within 10 working days of notification, repairs will not be acceptable. If the manufacturer requests the defective units to be shipped back, the manufacturer shall make arrangements to have them picked up at no cost to the City once the replacement units have been received.

3.0 OPTICAL AND LIGHT OUTPUT REQUIREMENTS

- 3.1 The LEDs shall be manufactured using Aluminum-Indium-Gallium-Phosphide (AlInGaP) technology or other LEDs with lower susceptibility to temperature degradation than Aluminum-Gallium-Arsenic (AlGaS). **AlGaS LEDs will not be allowed.**
- 3.2 Designs which require the light source LEDs to be operated at currents greater than 80% of the LED manufacturer's recommended drive current will not be accepted. Offerors should submit manufacturer data sheets for the light source LEDs being used and the schematic of the circuit design indicating voltage and current levels throughout the circuit.
- 3.3 The specific color of the LED traffic signal lamp and bicycle signal lamp shall be specified by the City.
- 3.4 Each LED traffic signal lamp and bicycle lamp unit shall meet minimum laboratory light intensity values and light output distribution as described in I.T.E. VTCShs LED Supplements for a minimum period of 120 months (10 years), based on normal use in traffic signal operation over an operating temperature range of -40°F (-40°C) to +165°F (+74°C).
- 3.5 Measured chromaticity coordinates of LED traffic signal lamp and bicycle lamp units shall conform to the chromaticity requirements detailed in Section 4.3 Chromaticity of the I.T.E. VTCShs LED Circular Signal Supplement or Section 4.3 Chromaticity of the I.T.E. VTCShs LED Vehicle Arrow Traffic Signal Supplement for circular and arrow indications respectfully for a minimum period of 120 months (10 years).
- 3.6 LED traffic signal lamp and bicycle lamp units tested or submitted for testing shall be representative of typical production units and the sample received shall be an exact replica. Optical testing shall be performed with LED units mounted in standard traffic signal sections without visors or hoods attached to the signal sections.
- 3.7 A lab test report from an independent lab for each LED traffic signal lamp and bicycle lamp model should include light intensity values at each ITE specific distribution test point (balls supplement table 1 or 2, for arrow supplement table 1 or 2). The lab report should document current, voltage, total harmonic distortion (THD) for each test point. The power factor (PF) associated with each model should be documented. A copy of the lab test report from an independent lab should be submitted to the City with the bid. The test should have been performed within 6 months prior to bid opening.

4.0 ELECTRICAL

- 4.1 Each LED traffic signal lamp and bicycle lamp unit shall incorporate a regulated power supply engineered to electrically protect the LEDs and maintain a safe and reliable operation. The power supply shall provide capacitor filtered DC regulated current to the LEDs per the LED manufacturer specification. Design of the power supply shall be such that the failure of an individual component or any combination of components cannot cause the signal to be illuminated after AC power is removed.
- 4.2 LED traffic signal lamp and bicycle lamp units shall be operationally compatible with type 170 cabinet designs. Under normal operating conditions, the LED lamp unit shall operate without inhibiting any Conflict Monitor features.

- 4.3 LED traffic signal lamps and bicycle lamps which require the light source LEDs to operate at currents greater than 80% of the LED manufacturer's recommended drive current will not be accepted. Offerors shall submit with their bids the manufacturer data sheets for the light source LED's being used in the traffic signal and bicycle LED lamps and the schematic of the circuit design used in each type of LED being bid indicating component values, voltages, and current levels throughout the circuit.
- 4.4 Circular, arrow, and bicycle lamp LED traffic signal lamp units shall be designed to sense a loss of light output due to catastrophic LED failure and react in compliance with the failed state impedance provision of the I.T.E. VTCSHs Circular Signal Supplement.
- 4.5 Two, captive, color coded, 600V, 18 AWG minimum jacketed wires, 3 feet (1 m) long, conforming to the National Electric Code, rated for service at 221°F (105°C), are to be provided for an electrical connection, Bi-Modal LED's shall have 3 wires (Brown wire for Green indication, Yellow wire for Yellow indication, White wire for AC Neutral). Six inches from the back of the LED the wires shall have a 2 wire (3 wire for Bi-Modal LED's) Molex connector series 3191 with a temperature rating of -40 to 105C Molex part # 0019092029. Each LED shall come with complete wiring assembly, to include plug and receptacle, allowing for quick disconnection after the LED is installed. The male connector shall be on the wire end attached to the LED. Each wire shall have a fully insulated female straight quick disconnect with fork adapter inserted for use on an 8/32 screw terminal. The connector insulation shall be made of a soft pliable material.
- 4.6 The LED traffic signal lamp and bicycle lamp units should have on-board circuitry including voltage surge protection, to withstand high-repetition noise transients and low-repetition high-energy transients as stated in Section 2.1.8, NEMA Standard TS 2-2003, except voltage should be 2000V instead of 1000V. The circuitry should also be able to withstand high-repetition low-energy transients as stated in Section 2.1.6, NEMA Standard TS 2-2003. Internal Glass fuses will not be allowed, internal solid state fuses of the type which will reset when power is removed from the LED unit will be required. In addition to documentation required in Section 7 below, schematic diagrams and theory of operation should be provided with your bid for each LED type being bid. Failure to provide this documentation may result in your bid being considered non-responsive.

5.0 OUTDOOR REQUIREMENTS

- 5.1 Environmental requirements shall meet or exceed I.T.E. VTCSHs LED Standard Supplements.
- 5.2 The LED traffic signal lamp and bicycle lamp units shall be rated for use in the ambient operating temperature range of 40°F (-40°C) to +165°F (+74°C).
- 5.3 The LED traffic signal lamp and bicycle lamp units shall be dust and moisture tight to protect all internal LED and electrical components.
- 5.4 The LED traffic signal lamp and bicycle lamp units shall consist of a housing that is a sealed watertight enclosure that eliminates dirt contamination and allows for safe handling and operation in all weather conditions. Moisture resistance testing shall be performed on LED signal modules in conformance with the requirements in the I.T.E. VTCSHs LED Standard Supplements. Evidence of internal moisture after testing shall be cause for rejection.

6.0 PRODUCTION TESTING REQUIREMENTS

- 6.1 A quality assurance (QA) program shall be in place at the manufacturer's facility to ensure product reliability.
- 6.2 Each new LED traffic signal lamp and bicycle lamp unit shall be energized for a minimum of 24 hours at nominal operating voltage (120V AC RMS) at room temperature in order to cause any electronic infant mortality to occur, and to ensure electronic component reliability prior to shipment.

7.0 DOCUMENTATION REQUIREMENTS

The following documentation should be submitted with bid:

- 7.1 Reference Section 3.2 above.
- 7.2 Reference Section 3.7 above.
- 7.3 Reference Section 4.6 above.
- 7.4 Offerors should submit a copy of a test report, certified by an independent laboratory, stating that the LED traffic signal lamp model submitted meets or exceeds the latest I.T.E. VTCSHs LED Supplemental Standards. The laboratory report should include documentation of tests and verification of compliance to the additional provisions of this standard. Tests performed by the independent lab should follow all the instructions documented in the latest I.T.E. VTCSHs circular signal supplement or latest I.T.E. VTCSHs arrow supplement as it pertains to the product being tested. Criteria in Section 3.7 above should be documented in the test report.

8.0 WARRANTY

- 8.1 Manufacturer shall comply with all requirements of the following warranty.
- 8.2 The LED traffic signal lamp and bicycle lamp units shall be warranted against any failure due to design, workmanship, material defects or reduced intensity within the first 120 months (10 years) of field operation. LED traffic signal lamp and bicycle lamp units shall meet or exceed minimum requirements of this specification for a period of no less than 120 months (10 years) of field operation.
- 8.3 Full replacement will be required if any LED traffic signal lamp and bicycle lamp that fails to operate as specified under normal operating conditions. Replaced LED traffic signal lamp units will be provided at no cost to City of Austin. The replaced LED traffic signal lamp units will inherit the remainder of the failed LED traffic signal lamp unit's warranty.
- 8.4 LED traffic signal lamp units and bicycle lamp units shall be replaced within 10 business days after notification at no cost to the City of Austin. The cost of shipping the LED traffic signal lamp and/or bicycle lamp units to the offeror (if required) shall be borne by the offeror or manufacturer.
- 8.5 If a LED traffic signal lamp and/or bicycle lamp unit fails with no visible damage to electronic/electrical components, (not including fuses or components designed to act as a fuse) or wiring, then the LED traffic signal unit is considered to have failed under normal operating conditions; A blown fuse, or a component acting as a fuse, without any other permanent failure to electrical/electronic components shall be considered to have failed under normal operating conditions. Acts-of-god will not be accepted as excusable unit failures without visible damage.
- 8.6 The manufacturer shall send replacement traffic signal lamps and/or bicycle lamps which the manufacturer has determined to have a known defect. The manufacturer shall send replacements for the individual lots which were shipped to the City of Austin, Transportation Department, within 20 working days after determining we were shipped defective traffic signal lamps and/or bicycle lamps. In the event the manufacturer requests the defective units back, arrangements to have the units shipped back shall be the responsibility of the manufacturer. The City of Austin, Transportation Department will not incur any costs for shipping units to and from the manufacturer. Within three (3) working days after notification by the City, the manufacturer shall make arrangements to have a contractor replace units which are part of the defective lot and have already been installed.

9.0 QUALITY ASSURANCE

- 9.1 The City of Austin may perform random sample testing on shipments. Random sample testing will be completed within 30 days after delivery.
- 9.2 Optical testing will be performed with the module mounted in a standard traffic signal section, but without a visor or hood attached to the section or housing. The number of modules tested will be determined by the quantity of each model in the shipment. The sample size shall conform to ANSI/ASQC Z1.4. Public Works, Traffic Operations Division, will determine the sampling parameters to be used for the random sample testing. All parameters of the specification may be tested on the modules. Acceptance or rejection of the shipment will conform to ANSI/ASQC Z1.4 for random sampled shipments.
- 9.3 The City of Austin reserves the right to select a sample from the field during the warranty period and perform tests to determine extended compliance and/or deterioration of the LED traffic signal lamp units.

10.0 QUALIFICATION TESTING

- 10.1 TxDOT, Traffic Operations Division, Traffic Signals Branch maintains a Qualified Products List (QPL) for LED traffic signal lamps and bicycle lamps meeting or exceeding this standard. LED traffic signal lamp units found on this list have been deemed acceptable for purchase by the City of Austin.
- 10.2 If a problem is found to exist with a LED traffic signal lamp or bicycle lamp unit (i.e. unsafe failure condition or excessive failure rate) on this list, it will be deemed unacceptable.
- 10.3 The City of Austin reserves the right to select a sample from the field during the warranty period and perform evaluation tests to determine extended compliance and/or deterioration of the LED traffic signal lamp unit.



BID SHEET CITY OF AUSTIN LED TRAFFIC LAMPS

SOLICITATION NO.: **IFB 2400 MDP0263**

BUYER: **Michelle Pearson**

Special Instructions: Offerors must use this Bid Sheet to submit pricing. Be advised that altering the bid sheet or taking exceptions to any portion of the solicitation may jeopardize acceptance of your Offer.

The quantities noted below are estimates and not a guarantee of actual volume. The City does not guarantee the purchase of the quantities listed, actual purchases may be more or less. Quantities are provided as a guide based on historical or anticipated usage. Order quantities will be as-needed and specified by the City for each order.

A bid of "0" (zero) will be interpreted by the City as a no-charge (free) item and the City will not expect to pay for that item. A bid of "no bid" or no response (space left blank) will be interpreted by the City that the Offeror does not wish to bid on that item. Be advised, a "no bid" or no response may be considered as non-responsive and may result in disqualification of the bid.

Prices offered on the bid sheet shall be all inclusive of fees not expressly allowed in Section 0500. The Offeror shall not charge separately for administrative, overhead, per diem, and shipping or transportation costs (travel time, fuel surcharges, mileage, stop-fee, etc.) to deliver services or items to the Austin, Texas area. The Offeror shall provide all tools, labor, travel, and equipment necessary to perform the services required under this contract.

The City reserves the right to award a single contract based on overall low cost or multiple awards based on individual or categories/groups of specific line items, cost, or any criteria or combination deemed most advantageous to the City.

ITEM NO.	ITEM DESCRIPTION	UNIT OF MEASURE	ESTIMATED ANNUAL QUANTITY	UNIT PRICE	EXTENDED PRICE
1	12" Red Ball LEDs for Traffic Signals	EACH	800	20.00	16,000.00
2	12" Yellow Ball LEDs for Traffic Signals	EACH	800	24.00	19,200.00
3	12" Green Ball LEDs for Traffic Signals	EACH	800	23.00	18,400.0
4	12" Red Arrow LEDs for Traffic Signals	EACH	450	24.00	10,800.00
5	12" Yellow Arrow LEDs for Traffic Signals	EACH	450	24.00	10,800.00
6	12" Green Arrow LEDs for Traffic Signals	EACH	450	23.00	10,350.00
7	12" Red Bicycle Symbol LEDs for Traffic Signals	EACH	75	52.00	3,900.00
8	12" Yellow Bicycle Symbol LEDs for Traffic Signals	EACH	75	52.00	3,900.00
9	12" Green Bicycle Symbol LEDs for Traffic Signals	EACH	75	52.00	3,900.00
10	12" Red U-Turn Arrow LEDs for Traffic Signals	EACH	75	44.00	3,300.00
11	12" Yellow U-Turn Arrow LEDs for Traffic Signals	EACH	75	44.00	3,300.00
12	12" Green U-Turn Arrow LEDs for Traffic Signals	EACH	75	44.00	3,300.00
TOTAL					107,150.00

DELIVERY TERMS: DELIVERY IS TO BE FOB DESTINATION, PREPAID AND ALLOWED

DELIVERY METHOD: ☒ COMMON CARRIER (FedEx,UPS) ☐ VENDOR DELIVERY

COMPANY NAME: Consolidated Traffic Controls, Inc.
WARRANTY INFORMATION: Provide name and telephone number of warranty information contact person: Alonzo Carrasco (817) 265-3421
EMAIL ADDRESS: acarrasco@ctc-traffic.com

SUBMITTAL REQUIREMENTS (CHECK TO CONFIRM):

REFERENCE 3.2 IN SECTION 0500 SPECIFICATIONS ☒
REFERENCE 3.7 IN SECTION 0500 SPECIFICATIONS ☒
REFERENCE 4.6 IN SECTION 0500 SPECIFICATIONS ☒
REFERENCE 7.4 IN SECTION 0500 SPECIFICATIONS ☒

Section 0605: Local Business Presence Identification

A firm (Offeror or Subcontractor) is considered to have a Local Business Presence if the firm is headquartered in the Austin Corporate City Limits, or has a branch office located in the Austin Corporate City Limits in operation for the last five (5) years, currently employs residents of the City of Austin, Texas, and will use employees that reside in the City of Austin, Texas, to support this Contract. The City defines headquarters as the administrative center where most of the important functions and full responsibility for managing and coordinating the business activities of the firm are located. The City defines branch office as a smaller, remotely located office that is separate from a firm's headquarters that offers the services requested and required under this solicitation.

OFFEROR MUST SUBMIT THE FOLLOWING INFORMATION FOR EACH LOCAL BUSINESS (INCLUDING THE OFFEROR, IF APPLICABLE) TO BE CONSIDERED FOR LOCAL PRESENCE.

NOTE: ALL FIRMS MUST BE IDENTIFIED ON THE MBE/WBE COMPLIANCE PLAN OR NO GOALS UTILIZATION PLAN (REFERENCE SECTION 0900).

USE ADDITIONAL PAGES AS NECESSARY

OFFEROR:

Name of Local Firm	N/A	
Physical Address		
Is your headquarters located in the Corporate City Limits? (circle one)	Yes	<input checked="" type="radio"/> No
or		
Has your branch office been located in the Corporate City Limits for the last 5 years?	Yes	<input checked="" type="radio"/> No
Will your business be providing additional economic development opportunities created by the contract award? (e.g., hiring, or employing residents of the City of Austin or increasing tax revenue?)	Yes	<input checked="" type="radio"/> No

SUBCONTRACTOR(S):

Name of Local Firm	N/A	
Physical Address		
Is your headquarters located in the Corporate City Limits? (circle one)	Yes	<input checked="" type="radio"/> No
or		
Has your branch office been located in the Corporate City Limits for the last 5 years	Yes	<input checked="" type="radio"/> No

Will your business be providing additional economic development opportunities created by the contract award? (e.g., hiring, or employing residents of the City of Austin or increasing tax revenue?)	Yes	No

SUBCONTRACTOR(S):

Name of Local Firm	N/A	
Physical Address		
Is your headquarters located in the Corporate City Limits? (circle one)	Yes	No
or		
Has your branch office been located in the Corporate City Limits for the last 5 years	Yes	No
Will your business be providing additional economic development opportunities created by the contract award? (e.g., hiring, or employing residents of the City of Austin or increasing tax revenue?)	Yes	No

Section 0700: Reference SheetResponding Company Name Consolidated Traffic Controls, Inc.

The City at its discretion may check references in order to determine the Offeror's experience and ability to provide the products and/or services described in this Solicitation. The Offeror shall furnish at least 3 complete and verifiable references. References shall consist of customers to whom the offeror has provided the same or similar services within the last 5 years. References shall indicate a record of positive past performance.

1. Company's Name City of Plano
Name and Title of Contact Robert Moore
Project Name _____
Present Address _____
City, State, Zip Code _____
Telephone Number (972) 769-4149 Fax Number (972) 769-4287
Email Address _____
2. Company's Name City of Duncanville
Name and Title of Contact John Borchardt
Project Name _____
Present Address _____
City, State, Zip Code _____
Telephone Number (214) 498-2183 Fax Number ()
Email Address _____
3. Company's Name City of Denton
Name and Title of Contact Scott Wilson
Project Name _____
Present Address _____
City, State, Zip Code _____
Telephone Number (940) 349-8491 Fax Number (940) 349-7307
Email Address _____

City of Austin, Texas

Section 0800

NON-DISCRIMINATION AND NON-RETALIATION CERTIFICATION

City of Austin, Texas

Equal Employment/Fair Housing Office

To: City of Austin, Texas,

I hereby certify that our firm complies with the Code of the City of Austin, Section 5-4-2 as reiterated below, and agrees:

- (1) Not to engage in any discriminatory employment practice defined in this chapter.
- (2) To take affirmative action to ensure that applicants are employed, and that employees are treated during employment, without discrimination being practiced against them as defined in this chapter, including affirmative action relative to employment, promotion, demotion or transfer, recruitment or recruitment advertising, layoff or termination, rate of pay or other forms of compensation, and selection for training or any other terms, conditions or privileges of employment.
- (3) To post in conspicuous places, available to employees and applicants for employment, notices to be provided by the Equal Employment/Fair Housing Office setting forth the provisions of this chapter.
- (4) To state in all solicitations or advertisements for employees placed by or on behalf of the Contractor, that all qualified applicants will receive consideration for employment without regard to race, creed, color, religion, national origin, sexual orientation, gender identity, disability, sex or age.
- (5) To obtain a written statement from any labor union or labor organization furnishing labor or service to Contractors in which said union or organization has agreed not to engage in any discriminatory employment practices as defined in this chapter and to take affirmative action to implement policies and provisions of this chapter.
- (6) To cooperate fully with City and the Equal Employment/Fair Housing Office in connection with any investigation or conciliation effort of the Equal Employment/Fair Housing Office to ensure that the purpose of the provisions against discriminatory employment practices are being carried out.
- (7) To require of all subcontractors having 15 or more employees who hold any subcontract providing for the expenditure of \$2,000 or more in connection with any contract with the City subject to the terms of this chapter that they do not engage in any discriminatory employment practice as defined in this chapter

For the purposes of this Offer and any resulting Contract, Contractor adopts the provisions of the City's Minimum Standard Non-Discrimination and Non-Retaliation Policy set forth below.

City of Austin

Minimum Standard Non-Discrimination and Non-Retaliation in Employment Policy

As an Equal Employment Opportunity (EEO) employer, the Contractor will conduct its personnel activities in accordance with established federal, state and local EEO laws and regulations.

The Contractor will not discriminate against any applicant or employee based on race, creed, color, national origin, sex, age, religion, veteran status, gender identity, disability, or sexual orientation. This policy covers all aspects of employment,

including hiring, placement, upgrading, transfer, demotion, recruitment, recruitment advertising, selection for training and apprenticeship, rates of pay or other forms of compensation, and layoff or termination.

The Contractor agrees to prohibit retaliation, discharge or otherwise discrimination against any employee or applicant for employment who has inquired about, discussed or disclosed their compensation.

Further, employees who experience discrimination, sexual harassment, or another form of harassment should immediately report it to their supervisor. If this is not a suitable avenue for addressing their complaint, employees are advised to contact another member of management or their human resources representative. No employee shall be discriminated against, harassed, intimidated, nor suffer any reprisal as a result of reporting a violation of this policy. Furthermore, any employee, supervisor, or manager who becomes aware of any such discrimination or harassment should immediately report it to executive management or the human resources office to ensure that such conduct does not continue.

Contractor agrees that to the extent of any inconsistency, omission, or conflict with its current non-discrimination and non-retaliation employment policy, the Contractor has expressly adopted the provisions of the City's Minimum Non-Discrimination Policy contained in Section 5-4-2 of the City Code and set forth above, as the Contractor's Non-Discrimination Policy or as an amendment to such Policy and such provisions are intended to not only supplement the Contractor's policy, but will also supersede the Contractor's policy to the extent of any conflict.

UPON CONTRACT AWARD, THE CONTRACTOR SHALL PROVIDE THE CITY A COPY OF THE CONTRACTOR'S NON-DISCRIMINATION AND NON-RETALIATION POLICIES ON COMPANY LETTERHEAD, WHICH CONFORMS IN FORM, SCOPE, AND CONTENT TO THE CITY'S MINIMUM NON-DISCRIMINATION AND NON-RETALIATION POLICIES, AS SET FORTH HEREIN, OR THIS NON-DISCRIMINATION AND NON-RETALIATION POLICY, WHICH HAS BEEN ADOPTED BY THE CONTRACTOR FOR ALL PURPOSES WILL BE CONSIDERED THE CONTRACTOR'S NON-DISCRIMINATION AND NON-RETALIATION POLICY WITHOUT THE REQUIREMENT OF A SEPARATE SUBMITTAL.

Sanctions:

Our firm understands that non-compliance with Chapter 5-4 and the City's Non-Retaliation Policy may result in sanctions, including termination of the contract and suspension or debarment from participation in future City contracts until deemed compliant with the requirements of Chapter 5-4 and the Non-Retaliation Policy.

Term:

The Contractor agrees that this Section 0800 Non-Discrimination and Non-Retaliation Certificate of the Contractor's separate conforming policy, which the Contractor has executed and filed with the City, will remain in force and effect for one year from the date of filing. The Contractor further agrees that, in consideration of the receipt of continued Contract payment, the Contractor's Non-Discrimination and Non-Retaliation Policy will automatically renew from year-to-year for the term of the underlying Contract.

Dated this 1st day of May, 2018

CONTRACTOR

Consolidated Traffic Controls, Inc.

Authorized Signature



Title

Estimator

Section 0835: Non-Resident Bidder Provisions

Company Name Consolidated Traffic Controls, Inc.

- A. Bidder must answer the following questions in accordance with Vernon's Texas Statutes and Codes Annotated Government Code 2252.002, as amended:

Is the Bidder that is making and submitting this Bid a "Resident Bidder" or a "non-resident Bidder"?

Answer: Resident

- (1) Texas Resident Bidder- A Bidder whose principle place of business is in Texas and includes a Contractor whose ultimate parent company or majority owner has its principal place of business in Texas.
(2) Nonresident Bidder- A Bidder who is not a Texas Resident Bidder.

- B. If the Bidder is a "Nonresident Bidder" does the state, in which the Nonresident Bidder's principal place of business is located, have a law requiring a Nonresident Bidder of that state to bid a certain amount or percentage under the Bid of a Resident Bidder of that state in order for the nonresident Bidder of that state to be awarded a Contract on such bid in said state?

Answer: _____ Which State: _____

- C. If the answer to Question B is "yes", then what amount or percentage must a Texas Resident Bidder bid under the bid price of a Resident Bidder of that state in order to be awarded a Contract on such bid in said state?

Answer: _____

**MINORITY- AND WOMEN-OWNED BUSINESS ENTERPRISE (MBE/WBE)
PROCUREMENT PROGRAM**

Subcontracting/Sub-Consulting ("Subcontractor") Utilization Form

SOLICITATION NUMBER: IFB 2400 MDP0263

SOLICITATION TITLE: LED Traffic Lamps

In accordance with the City of Austin's Minority and Women-Owned Business Enterprises (M/WBE) Procurement Program (Program), Chapters 2-9A/B/C/D of the City Code and M/WBE Program Rules, this Solicitation was reviewed by the Small and Minority Business Resources Department (SMBR) to determine if M/WBE Subcontractor/Sub-Consultant ("Subcontractor") Goals could be applied. Due to insufficient subcontracting/subconsultant opportunities and/or insufficient availability of M/WBE certified firms, SMBR has assigned no subcontracting goals for this Solicitation. However, Offerors who choose to use Subcontractors must comply with the City's M/WBE Procurement Program as described below. Additionally, if the Contractor seeks to add Subcontractors after the Contract is awarded, the Program requirements shall apply to any Contract(s) resulting from this Solicitation.

Instructions:

- a.) Offerors who do not intend to use Subcontractors shall check the "NO" box and follow the corresponding instructions.
b.) Offerors who intend to use Subcontractors shall check the applicable "YES" box and follow the instructions. **Offers that do not include the following required documents shall be deemed non-compliant or nonresponsive as applicable, and the Offeror's submission may not be considered for award.**

☒ **NO, I DO NOT intend to use Subcontractors/Sub-consultants.**

Instructions: Offerors that do not intend to use Subcontractors shall complete and sign this form below (Subcontracting/Sub-Consulting ("Subcontractor") Utilization Form) and include it with their sealed Offer.

☐ **YES, I DO intend to use Subcontractors/Sub-consultants.**

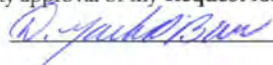
Instructions: Offerors that do intend to use Subcontractors shall complete and sign this form below (Subcontracting/Sub-Consulting ("Subcontractor") Utilization Form), and follow the additional Instructions in the (Subcontracting/Sub-Consulting ("Subcontractor") Utilization Plan). Contact SMBR if there are any questions about submitting these forms.

Offeror Information

Company Name			
City Vendor ID Code			
Physical Address			
City, State Zip			
Phone Number		Email Address	
Is the Offeror City of Austin M/WBE certified?	<input type="checkbox"/> NO <input type="checkbox"/> YES Indicate one: <input type="checkbox"/> MBE <input type="checkbox"/> WBE <input type="checkbox"/> MBE/WBE Joint Venture		

Offeror Certification: I understand that even though SMBR did not assign subcontract goals to this Solicitation, I will comply with the City's M/WBE Procurement Program if I intend to include Subcontractors in my Offer. I further agree that this completed **Subcontracting/Sub-Consulting Utilization Form**, and if applicable my completed **Subcontracting/Sub-Consulting Utilization Plan**, shall become a part of any Contract I may be awarded as the result of this Solicitation. Further, if I am awarded a Contract and I am not using Subcontractor(s) but later intend to add Subcontractor(s), before the Subcontractor(s) is hired or begins work, I will comply with the City's M/WBE Procurement Program and submit the **Request For Change** form to add any Subcontractor(s) to the Project Manager or the Contract Manager for prior authorization by the City and perform Good Faith Efforts (GFE), if applicable. I understand that, if a Subcontractor is not listed in my **Subcontracting/Sub-Consulting Utilization Plan**, it is a violation of the City's M/WBE Procurement Program for me to hire the Subcontractor or allow the Subcontractor to begin work, unless I first obtain City approval of my **Request for Change** form. I understand that, if a Subcontractor is not listed in my **Subcontracting/Sub-Consulting Utilization Plan**, it is a violation of the City's M/WBE Procurement Program for me to hire the Subcontractor or allow the Subcontractor to begin work, unless I first obtain City approval of my **Request for Change** form.

Mark O'Barr, Estimator

 5/1/2018

Name and Title of Authorized Representative (Print or Type)

Signature/Date



**ADDENDUM
PURCHASING OFFICE
CITY OF AUSTIN, TEXAS**

Solicitation: IFB 2400 MDP0263

Addendum No: 1

Date of Addendum: 04/27/2018

This addendum is to incorporate the following changes to the above referenced solicitation:

I. Questions:

- Q1. Is the material ABS or Aluminum Die Casting?
A1. The City's specification does not specify the type of material to be used in the construction of the LED traffic signal module. However, the materials used must meet the requirements of our specification and all other referenced specifications.
- Q2. Can you please provide pictures to confirm the appearance of the lamps?
A2. The City is not requesting brand-specific LED traffic lamps. To be considered for award, the products must meet the City of Austin specifications. Therefore, we do not have pictures to share.
- Q3. What was the last awarded price of each item?
A3. Attached is the bid tab from the previous contract:
https://assets.austintexas.gov/financeonline/downloads/vc_files/IFB_2400_SDC0243/IFB_2400_SDC0243_BID_TAB_v1.pdf
- Q4. Does the City require Worker's Compensation and Auto Liability Insurance if the product is being delivered via common carrier?
A4. No. If shipment is made by common carrier, then the requirements for Worker's Compensation Employee Liability and Business Automobile Liability Insurance are not required. The Contractor must identify the delivery method in the Section 0600 Bid Sheet.
- Q5. The City is requiring individual lot numbers. Is the City asking for serial number on individual LED or something different?
A5. The City requires the lot number. The lot number is the number which the LED Traffic Lamp manufacturer assigns to a group of LED Traffic Lamps to assist in identifying the production run. Within that group, each LED Traffic Lamp has its own serial number.

II. ALL OTHER TERMS AND CONDITIONS REMAIN THE SAME.

APPROVED BY: _____

Michelle Pearson, Procurement Specialist II
Purchasing Office, 512-974-2023

Date

4/27/18

ACKNOWLEDGED BY:

MARK O'BARR

Name

D. Yach O'Barr

Authorized Signature

5/1/2018

Date

RETURN ONE COPY OF THIS ADDENDUM TO THE PURCHASING OFFICE, CITY OF AUSTIN, WITH YOUR RESPONSE OR PRIOR TO THE SOLICITATION CLOSING DATE. FAILURE TO DO SO MAY CONSTITUTE GROUNDS FOR REJECTION.



Issue Date: January 27, 2017
Project No. G102785964
Quote No.: Qu-00734330

Contact: Hamid Kashani
Email: hamid@leotek.com
Phone No. 408-380-1788

Report No. 102785964CRT-001G

Leotek Electronics USA LLC

1955 Lundy Ave
San Jose, CA 95131

Standards

Performance Specification of the Institute of Transportation Engineers, Vehicle Traffic Control Signal Heads: Light Emitting Diode (LED) Vehicle Arrow Traffic Signal Supplement, dated July 1, 2007.

Standard Specifications Caltrans dated 2010. Section 86-4.01D(2)(a)

Test Purpose	ITE 5-Year Re-Certification Testing of Models; TSL-12GA-IL6-A1 & TSL-12GA-IL6-A1-CLR
Test Dates	October 27, 2016 through January 26, 2017

John C. Robins
Engineer
Lighting

Christopher W. Metcalf
Engineering Supervisor
Lighting

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Test Plan and Datasheets			
Client	Leotek Electronics USA LLC	Engineer	John C. Robins
Report #	102785964CRT-001G	Reviewer	Christopher W. Metcalf
Product	12" Green Omni Arrow Tinted & Clear	Model(s)	TSL-12GA-IL6-A1 & TSL-12GA-IL6-A1-CLR
Standard	ITE, Vehicle Arrow Traffic Signal Supplement, dated July 1, 2007.		

Spec	Test name	Clause	Pass Fail NA
ITE	Conditioning	6.4.2	Pass
ITE	Mechanical Vibration	6.4.3.1	Pass
ITE	Temperature Cycling	6.4.3.2	Pass
ITE	Moisture Resistance	6.4.3.3	Pass
ITE	Luminous Intensity	6.4.4.1, 2,3,4	Pass
ITE	Luminance Uniformity	6.4.4.5	Pass
ITE	Chromaticity	6.4.4.6	Pass
ITE	Color Uniformity	6.4.4.7	Pass
ITE	Lens Abrasion Resistance	6.4.5.2	Pass
ITE	Current Consumption	6.4.6.1	Pass
ITE	Low Voltage Turn Off	6.4.6.2	Pass
ITE	Turn-On/Turn-Off Times	6.4.6.3	Pass
ITE	Transient Voltage Immunity	6.4.6.4	Pass
ITE	Electronic Noise	6.4.6.5	Pass
ITE	Power Factor & Total Harmonic Distortion	6.4.6.6, 7	Pass
ITE	Load Switch Compatibility	6.4.7.1	Pass
ITE	Off State Voltage Decay	6.4.7.2	Pass
ITE	Failed State Impedance	6.4.8	Pass

Sample Information				
Date Rec.	Intertek ID	Description	Condition	Model No.
10/24/2016	CRT1610241001-003	12" Green Omni Arrow Tinted	Production	TSL-12GA-IL6-A1
10/24/2016	CRT1610241001-002	12" Green Omni Arrow Tinted	Production	TSL-12GA-IL6-A1
11/7/2016	CRT1611071057-001	12" Green Omni Arrow Clear	Production	TSL-12GA-IL6-A1-CLR
11/7/2019	CRT1611071057-003	12" Green Omni Arrow Clear	Production	TSL-12GA-IL6-A1-CLR

Further Sample Description

Intertek Sample Number	Description	Model Number	Serial Number
CRT1610241001-003-001	12" Green Omni ArrowTinted	TSL-12GA-IL6-A1	16917545
CRT1610241001-003-002	12" Green Omni ArrowTinted	TSL-12GA-IL6-A1	16917546
CRT1610241001-003-003	12" Green Omni ArrowTinted	TSL-12GA-IL6-A1	16917547
CRT1610241001-003-004	12" Green Omni ArrowTinted	TSL-12GA-IL6-A1	16917548
CRT1610241001-003-005	12" Green Omni ArrowTinted	TSL-12GA-IL6-A1	16917549
CRT1610241001-002-003	12" Green Omni ArrowTinted	TSL-12GA-IL6-A1	16917550
CRT1611071057-001-001	12" Green Omni Arrow Clear	TSL-12GA-IL6-A1-CLR	T16B025
CRT1611071057-001-002	12" Green Omni Arrow Clear	TSL-12GA-IL6-A1-CLR	T16B026
CRT1611071057-003-001	12" Green Omni Arrow Clear	TSL-12GA-IL6-A1-CLR	T16B027

General Requirements

Intertek Sample Number	ETL Cert. Number	Label Identification	Lens Orientation	Color Coded Wires
CRT1610241001-003-001	7080615	Pass	Pass	Brown/White
CRT1610241001-003-002	7080616	Pass	Pass	Brown/White
CRT1610241001-003-003	7080617	Pass	Pass	Brown/White
CRT1610241001-003-004	7080618	Pass	Pass	Brown/White
CRT1610241001-003-005	7080619	Pass	Pass	Brown/White
CRT1610241001-002-003	7080620	Pass	Pass	Brown/White
CRT1611071057-001-001	6596147	Pass	Pass	Brown/White
CRT1611071057-001-002	6596149	Pass	Pass	Brown/White
CRT1611071057-003-001	6596148	Pass	Pass	Brown/White

General Requirements

Intertek Sample Number	600V / 20 AWG Min.	Wire Length \geq 39"	Service Rating +105°C
CRT1610241001-003-001	600V/18AWG	Pass	Pass
CRT1610241001-003-002	600V/18AWG	Pass	Pass
CRT1610241001-003-003	600V/18AWG	Pass	Pass
CRT1610241001-003-004	600V/18AWG	Pass	Pass
CRT1610241001-003-005	600V/18AWG	Pass	Pass
CRT1610241001-002-003	600V/18AWG	Pass	Pass
CRT1611071057-001-001	600V/18AWG	Pass	Pass
CRT1611071057-001-002	600V/18AWG	Pass	Pass
CRT1611071057-003-001	600V/18AWG	Pass	Pass

Picture(s)

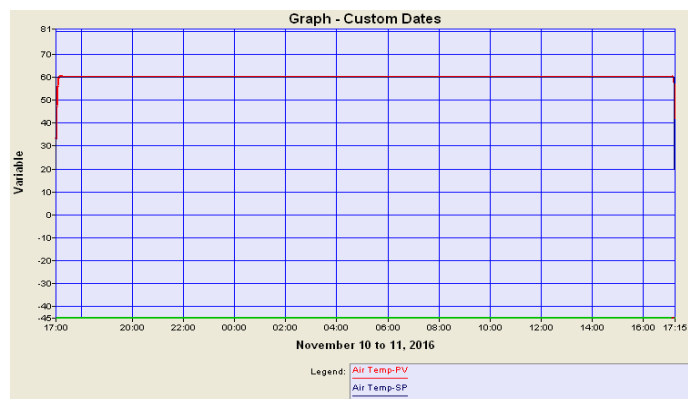
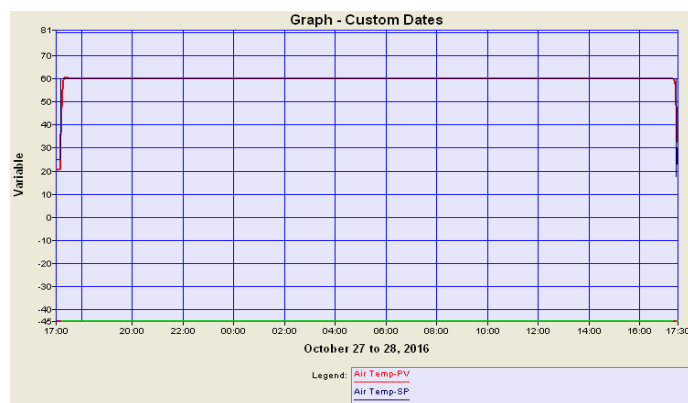


Conditioning 6.4.2

The submitted LED signal modules were subjected to conditioning prior to the environmental tests. The samples were energized for a minimum of 24 hours, at 100% duty cycle in an ambient temperature of +60°C (+140°F). At the conclusion of the test, the modules shall be visually inspected for damage and checked for proper operation.

Results

Intertek Sample Number	Description	Visual Inspection		Operational Check	
		Pre	Post	Pre	Post
CRT1610241001-003-001	12" Green Omni ArrowTinted	Pass	Pass	Pass	Pass
CRT1610241001-003-002	12" Green Omni ArrowTinted	Pass	Pass	Pass	Pass
CRT1610241001-003-003	12" Green Omni ArrowTinted	Pass	Pass	Pass	Pass
CRT1610241001-003-004	12" Green Omni ArrowTinted	Pass	Pass	Pass	Pass
CRT1610241001-003-005	12" Green Omni ArrowTinted	Pass	Pass	Pass	Pass
CRT1610241001-002-003	12" Green Omni ArrowTinted	Pass	Pass	Pass	Pass
CRT1611071057-001-001	12" Green Omni Arrow Clear	Pass	Pass	Pass	Pass
CRT1611071057-001-002	12" Green Omni Arrow Clear	Pass	Pass	Pass	Pass
CRT1611071057-003-001	12" Green Omni Arrow Clear	Pass	Pass	Pass	Pass



Measured Voltage: 119.3 Vac

Complies: ☒ YES ☐ NO

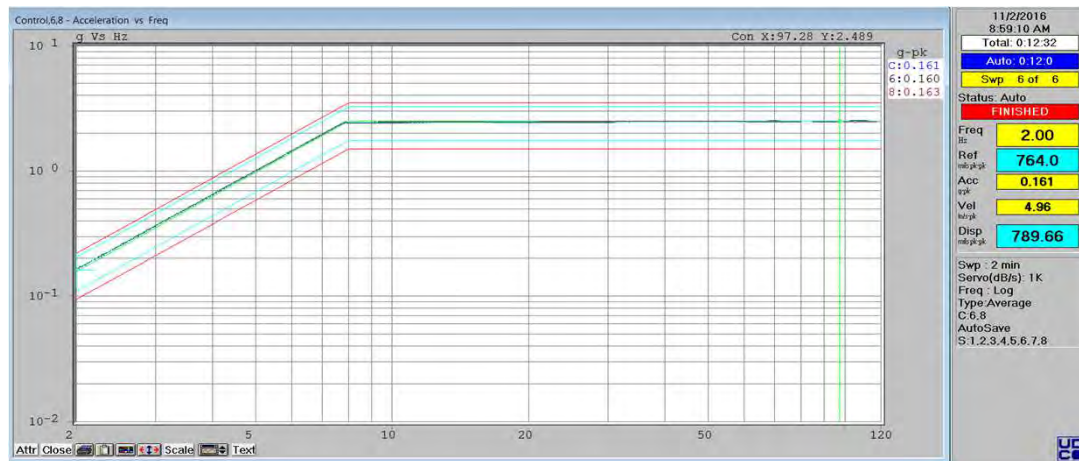
Tested By:	John Robins	Signature or initials:	<i>JR</i>	Comp. Date	10/28/16
Reviewed By:	cwm	Signature or initials:	<i>cwm</i>	Comp. Date	11/11/16
Test Equipment Used:	1,2				
Amb (°C):	na	RH%	na		

Mechanical Vibration 6.4.3.1

The submitted LED signal modules were securely mounted in traffic signal housings and vibrated along each axes for three 4 minute sweep cycles at a displacement of 0.764" from 2 to 8 Hz and 2.5 Gs from 8 to 120 Hz. The modules were energized before and after each axis sweep. The modules were visually inspected after testing. Testing was conducted in accordance with MIL-STD-883, method 2007. At the conclusion of the test, the module shall be free of damage and fully operational.

Results

Intertek Sample Number	Description	x-axis lateral	y-axis horizontal	z-axis vertical	Visual Inspection	Operational Check
CRT1610241001-003-001	12" Green Omni ArrowTinted	X	X	X	Pass	Pass
CRT1610241001-003-002	12" Green Omni ArrowTinted	X	X	X	Pass	Pass
CRT1610241001-003-003	12" Green Omni ArrowTinted	X	X	X	Pass	Pass
CRT1610241001-003-004	12" Green Omni ArrowTinted	X	X	X	Pass	Pass
CRT1610241001-003-005	12" Green Omni ArrowTinted	X	X	X	Pass	Pass
CRT1610241001-002-003	12" Green Omni ArrowTinted	X	X	X	Pass	Pass

Complies: ☒ YES ☐ NO

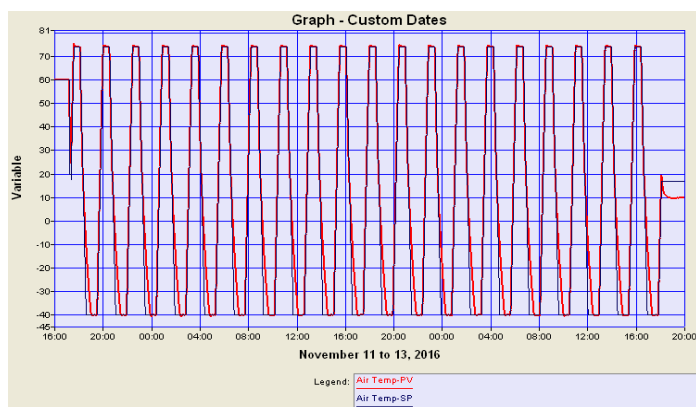
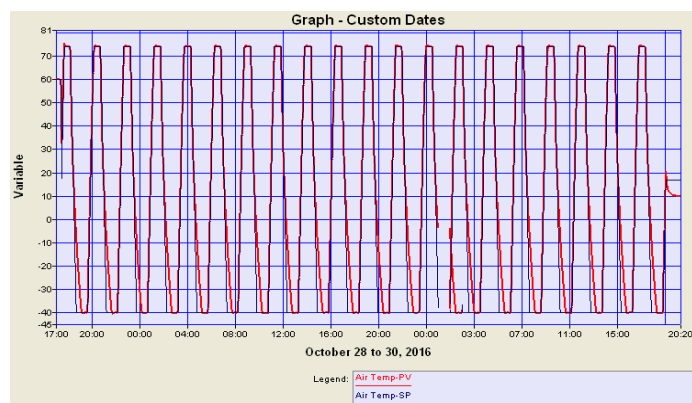
Tested By:	Gordon West	Signature or initials:	<i>Gordon West</i>	Comp. Date	11/2/16
Reviewed By:	cwm	Signature or initials:	<i>cwm</i>		
Test Equipment Used:	3,4,5,6,7				
Amb (°C):	23.1	RH%	35		

Temperature Cycling 6.4.3.2

The submitted tinted and clear LED signal modules were subjected to temperature cycling according to MIL-STD-883, Method 1010. Twenty cycles were performed with a 30 minute transfer time between temperature extremes and a 30 minute dwell time at the extremes. The temperature cycled between -40°C and +74°C. The samples were non-operating. At the conclusion of the test, the module shall be free of damage and moisture and be fully operational.

Results

Intertek Sample Number	Description	Visual Inspection	Operational Check
CRT1610241001-003-001	12" Green Omni ArrowTinted	Pass	Pass
CRT1610241001-003-002	12" Green Omni ArrowTinted	Pass	Pass
CRT1610241001-003-003	12" Green Omni ArrowTinted	Pass	Pass
CRT1610241001-003-004	12" Green Omni ArrowTinted	Pass	Pass
CRT1610241001-003-005	12" Green Omni ArrowTinted	Pass	Pass
CRT1610241001-002-003	12" Green Omni ArrowTinted	Pass	Pass
CRT1611071057-001-001	12" Green Omni Arrow Clear	Pass	Pass
CRT1611071057-001-002	12" Green Omni Arrow Clear	Pass	Pass
CRT1611071057-003-001	12" Green Omni Arrow Clear	Pass	Pass



Complies: ☒ YES ☐ NO

Tested By:	John Robins	Signature or initials:	<i>JR</i>	Comp. Date	10/30/16
Reviewed By:	cwm	Signature or initials:	<i>cwm</i>	Comp. Date	11/13/16
Test Equipment Used:	2				
Amb (°C):	na	RH%	na		

Moisture Resistance 6.4.3.3

The submitted tinted and clear LED signal modules were subjected to the rain and blowing rain test per MIL-STD-810F, Test Method 506.4, Procedure I. The test was performed on standalone modules without a protective housing. The rainfall rate was 1.7 mm/min (4in/hr) and the droplet size shall predominantly be between 0.5mm and 4.5mm (0.02 to 0.18 in). The samples were oriented such that the lens is directed towards the wind source when at a zero rotation angle. The samples were rotated at a rate of 4 degrees per minute along the vertical axis, from an orientation of -60 to +60 degrees during the test. The duration of the test is 30 minutes, and the samples were energized throughout the test. The water temperature was $25^{\circ} \pm 5^{\circ}\text{C}$ ($77^{\circ} \pm 9^{\circ}\text{F}$) and the wind velocity was 80 km/hr (50 mph). At the conclusion of the test, the module shall be free of damage and moisture and be fully operational.

Results

Intertek Sample Number	Description	Visual Inspection	Operational Check
CRT1610241001-003-001	12" Green Omni ArrowTinted	pass	pass
CRT1610241001-003-002	12" Green Omni ArrowTinted	pass	pass
CRT1610241001-003-003	12" Green Omni ArrowTinted	pass	pass
CRT1610241001-003-004	12" Green Omni ArrowTinted	pass	pass
CRT1610241001-003-005	12" Green Omni ArrowTinted	pass	pass
CRT1610241001-002-003	12" Green Omni ArrowTinted	pass	pass
CRT1611071057-001-001	12" Green Omni Arrow Clear	pass	pass
CRT1611071057-001-002	12" Green Omni Arrow Clear	pass	pass
CRT1611071057-003-001	12" Green Omni Arrow Clear	pass	pass

Requirement: Signal Still Operational and No Moisture In The Housing

Intertek Sample Number	Sample Temp. at start (°C)	Water Temperature 25C +/- 5C			
		Start	10 minutes in.	20 minutes in.	30 minutes in.
CRT1610241001-003-001	40	22.7	20.1	24.3	28.5
CRT1610241001-003-002	40				
CRT1610241001-003-003	40	28.5	23.6	22.0	20.1
CRT1610241001-003-004	40				
CRT1610241001-003-005	40	20.1	29.8	20.2	20.2
CRT1610241001-002-003	40				
CRT1611071057-001-001	40	20.2	20.4	21.1	26.2
CRT1611071057-001-002	40				
CRT1611071057-003-001	40	26.8	27.4	27.1	27.3

* Water temperature is °C

Recorded rainfall rate:	4.3	in/hr
Recorded wind velocity:	48-52	mph

Complies: ☒ YES ☐ NO

Tested By:	Kurt Dobler	Signature or initials:	kfd	Comp. Date	1/26/17
Reviewed By:	cwm	Signature or initials:	<i>[Signature]</i>		
Test Equipment Used:	20,21,22,23				
Amb (°C):	na		na		

Luminous Intensity 6.4.4.1 through 6.4.4.4

The intensity distribution tests on the submitted LED traffic signal modules were performed with the Intertek 25 meter Goniophotometer. The goniophotometer was in accordance with the goniometer described in Section 11.02 (Test Apparatus) of the Institute of Transportation Engineers' Vehicle Traffic Control Signal Heads Standard Test Method. The calibration of the goniophotometer is traceable to the National Institute of Standards and Technology. The LED modules were operated at 120 volts AC. The alignment of the LED module was performed in accordance with Section 11.03 (Alignment of Optical Unit for Test) of the Institute of Transportation Engineers' Vehicle Traffic Control Signal Heads Standard Test Method. The submitted LED signal modules were tested for maintained minimum luminous intensity at each of 112 points indicated in Table 3, of the referenced specification. These measurements were recorded at an ambient temperature of 25°C. The green LED signal modules were energized at nominal operating voltage, at a 100% duty cycle for 60 minutes.

A relative luminous intensity measurement is taken in a region from 0 to 7.5° down, and from 7.5° left to 7.5° right. The measurement is taken at 80 Vac, 120 Vac and 135 Vac. When the 80 Vac and 135 Vac factors are applied to the photometric data the units shall still meet the photometric requirements of each model.

A diminution factor was measured by using the submitted samples. The modules were mounted in a dual compartment temperature chamber with the lensed portion in one compartment and all portions behind the lens within the other compartment. At room ambient temperature (both inside and outside the chamber) and in calm air outside the chamber, the modules were energized per the conditions described above and a single on-axis reading (IA) taken and recorded. With the modules off, the chamber was heated to 74°C behind the lens and 49°C in front of the lens, and allowed to stabilize. Following stabilization, the modules were energized per the above cycle and the single on-axis reading (IH) taken and recorded. A diminution factor was calculated (IH/IA). The readings recorded initially were factored by the diminution factor.

Luminous Intensity 6.4.4.1 through 6.4.4.4

Sample	CRT1610241001-003-004			Target Input voltage		Measured Input Voltage		0, 0 Lum. Intensity		Vac Variation Factor		MMLI Factor		
Module	12" Omni Arrow			80Vac		80.2		Vac		94.1		0.984		
Color:	Green			120Vac		120.3		Vac		95.7		1.000		
Lens	Tinted			135Vac		135.2		Vac		94.4		0.987		
Photometric Test Distance: 5 meters														
Max	228	25°C		25°C		25°C		74°C/49°C		74°C/49°C		74°C/49°C		
Vertical	Horizontal	Rated 80Vac		Measured 120Vac		Rated 135Vac		Rated 80Vac		Measured 120Vac		Rated 135Vac		Table 3
Angle	Angle	Candela	Candela	Candela	Candela	Candela	Candela	Candela	Candela	Candela	Candela	Candela	Candela	Minimum
Up/Down	Left/Right	Left	Right	Left	Right	Left	Right	Left	Right	Left	Right	Left	Right	Candela
27.5U	7.5	8.2	8.3	8.3	8.4	8.2	8.3	7.9	8.0	8.0	8.1	7.9	8.0	3.6
27.5U	2.5	9.8	9.9	10.0	10.1	9.8	9.9	9.5	9.6	9.6	9.7	9.5	9.6	4.3
22.5U	17.5	5.9	6.9	6.0	7.0	5.9	6.9	5.7	6.7	5.8	6.8	5.7	6.7	3.8
22.5U	12.5	9.6	9.8	9.7	10.0	9.6	9.9	9.2	9.5	9.4	9.6	9.3	9.5	6.4
22.5U	7.5	15.2	14.9	15.4	15.2	15.2	15.0	14.6	14.4	14.9	14.6	14.7	14.4	9.2
22.5U	2.5	19.4	19.2	19.7	19.6	19.5	19.3	18.7	18.6	19.0	18.9	18.8	18.6	11.1
17.5U	22.5	5.9	7.0	6.0	7.1	6.0	7.0	5.7	6.8	5.8	6.9	5.7	6.8	3.8
17.5U	17.5	9.6	10.7	9.8	10.8	9.7	10.7	9.3	10.3	9.5	10.5	9.3	10.3	7.8
17.5U	12.5	17.9	18.6	18.2	18.9	17.9	18.7	17.3	17.9	17.6	18.2	17.3	18.0	13.6
17.5U	7.5	31.0	29.9	31.5	30.4	31.1	30.0	29.9	28.8	30.4	29.3	30.0	28.9	19.7
17.5U	2.5	39.5	39.6	40.1	40.2	39.6	39.7	38.1	38.2	38.7	38.8	38.2	38.3	23.7
12.5U	22.5	8.6	10.7	8.8	10.9	8.7	10.7	8.3	10.3	8.5	10.5	8.4	10.4	6.4
12.5U	17.5	16.6	19.6	16.9	19.9	16.6	19.6	16.0	18.9	16.3	19.2	16.1	18.9	13.6
12.5U	12.5	32.4	35.3	32.9	35.9	32.5	35.4	31.3	34.0	31.8	34.6	31.4	34.2	23.9
12.5U	7.5	52.4	53.1	53.3	54.0	52.6	53.3	50.5	51.3	51.4	52.1	50.7	51.4	34.7
12.5U	2.5	67.9	65.3	69.0	66.4	68.1	65.5	65.5	63.0	66.6	64.0	65.7	63.2	41.8
7.5U	27.5	6.8	8.6	7.0	8.8	6.9	8.6	6.6	8.3	6.7	8.4	6.6	8.3	3.6
7.5U	22.5	14.1	18.7	14.4	19.0	14.2	18.7	13.6	18.0	13.9	18.3	13.7	18.1	9.2
7.5U	17.5	28.6	35.6	29.1	36.2	28.7	35.8	27.6	34.4	28.0	35.0	27.7	34.5	19.7
7.5U	12.5	53.4	56.5	54.3	57.4	53.6	56.7	51.6	54.5	52.4	55.4	51.7	54.7	34.7
7.5U	7.5	76.9	74.0	78.2	75.3	77.1	74.3	74.2	71.4	75.4	72.6	74.4	71.7	50.6
7.5U	2.5	83.6	85.3	85.0	86.7	83.9	85.5	80.7	82.3	82.0	83.6	80.9	82.5	61.1
2.5U	27.5	8.9	11.7	9.1	11.9	8.9	11.8	8.6	11.3	8.7	11.5	8.6	11.3	4.3
2.5U	22.5	20.9	26.9	21.3	27.4	21.0	27.0	20.2	26.0	20.5	26.4	20.3	26.0	11.1
2.5U	17.5	42.8	48.4	43.6	49.2	43.0	48.6	41.3	46.7	42.0	47.5	41.5	46.9	23.7
2.5U	12.5	67.0	69.2	68.1	70.4	67.2	69.4	64.7	66.8	65.7	67.9	64.9	67.0	41.8
2.5U	7.5	83.2	85.4	84.6	86.8	83.4	85.6	80.3	82.4	81.6	83.7	80.5	82.6	61.1
2.5U	2.5	91.1	93.3	92.7	94.8	91.4	93.6	88.0	90.0	89.4	91.5	88.2	90.3	73.9
2.5D	2.5	95.9	95.8	97.6	97.4	96.3	96.1	92.6	92.4	94.1	94.0	92.9	92.7	73.9
2.5D	7.5	85.3	84.4	86.7	85.8	85.5	84.7	82.3	81.4	83.7	82.8	82.5	81.7	61.1
2.5D	12.5	69.9	69.2	71.0	70.3	70.1	69.4	67.4	66.7	68.5	67.9	67.6	67.0	41.8
2.5D	17.5	49.7	51.1	50.5	51.9	49.8	51.2	47.9	49.3	48.7	50.1	48.1	49.4	23.7
2.5D	22.5	25.1	27.7	25.5	28.2	25.2	27.8	24.2	26.7	24.6	27.2	24.3	26.8	11.1
2.5D	27.5	10.0	10.8	10.1	11.0	10.0	10.8	9.6	10.4	9.8	10.6	9.6	10.4	4.3
7.5D	2.5	89.2	89.4	90.7	90.9	89.5	89.7	86.1	86.3	87.5	87.7	86.3	86.6	61.1
7.5D	7.5	80.7	79.4	82.1	80.7	81.0	79.6	77.9	76.6	79.2	77.9	78.2	76.8	50.6
7.5D	12.5	59.8	59.2	60.8	60.2	60.0	59.4	57.7	57.2	58.7	58.1	57.9	57.3	34.7
7.5D	17.5	36.6	38.0	37.2	38.7	36.7	38.1	35.3	36.7	35.9	37.3	35.5	36.8	19.7
7.5D	22.5	18.8	18.3	19.1	18.6	18.9	18.4	18.2	17.7	18.5	18.0	18.2	17.7	9.2
7.5D	27.5	7.5	6.9	7.7	7.0	7.6	6.9	7.3	6.7	7.4	6.8	7.3	6.7	3.6
12.5D	2.5	73.3	74.1	74.5	75.4	73.5	74.4	70.7	71.5	71.9	72.7	70.9	71.8	41.8
12.5D	7.5	57.6	62.5	58.5	63.6	57.8	62.7	55.5	60.3	56.5	61.3	55.7	60.5	34.7
12.5D	12.5	38.1	40.9	38.7	41.6	38.2	41.0	36.7	39.5	37.4	40.1	36.9	39.6	23.9
12.5D	17.5	21.1	20.5	21.5	20.9	21.2	20.6	20.4	19.8	20.7	20.1	20.4	19.9	13.6
12.5D	22.5	10.0	9.4	10.2	9.6	10.0	9.4	9.6	9.1	9.8	9.2	9.7	9.1	6.4
17.5D	2.5	53.6	54.2	54.5	55.1	53.8	54.3	51.7	52.3	52.6	53.1	51.9	52.4	23.7
17.5D	7.5	36.3	40.7	36.9	41.4	36.4	40.8	35.0	39.2	35.6	39.9	35.1	39.4	19.7
17.5D	12.5	21.5	24.6	21.8	25.0	21.5	24.7	20.7	23.8	21.1	24.2	20.8	23.8	13.6
17.5D	17.5	10.0	10.7	10.2	10.9	10.0	10.8	9.7	10.3	9.8	10.5	9.7	10.4	7.8
17.5D	22.5	4.9	5.1	5.0	5.2	5.0	5.1	4.8	4.9	4.8	5.0	4.8	5.0	3.8
22.5D	2.5	25.2	26.4	25.6	26.9	25.3	26.5	24.3	25.5	24.7	25.9	24.4	25.6	11.1
22.5D	7.5	17.9	19.3	18.2	19.7	18.0	19.4	17.3	18.7	17.6	19.0	17.3	18.7	9.2
22.5D	12.5	10.2	11.3	10.4	11.5	10.3	11.3	9.9	10.9	10.0	11.1	9.9	10.9	6.4
22.5D	17.5	5.2	5.7	5.3	5.8	5.3	5.8	5.1	5.5	5.1	5.6	5.1	5.6	3.8
27.5D	2.5	10.9	11.5	11.1	11.7	11.0	11.5	10.5	11.1	10.7	11.3	10.6	11.1	4.3
27.5D	7.5	8.3	9.5	8.5	9.7	8.4	9.6	8.1	9.2	8.2	9.3	8.1	9.2	3.6

Luminous Intensity 6.4.4.1 through 6.4.4.4

Sample	CRT1610241001-003-005					Target Input voltage		Measured Input Voltage		0, 0 Lum. Intensity		Vac Variation Factor		MMLI Factor	
Module	12" Omni Arrow					80Vac		80.2 Vac		98.6 Candela		0.983		0.980	
Color:	Green					120Vac		120.6 Vac		100.3 Candela		1.000			
Lens	Tinted					135Vac		135.2 Vac		102.1 Candela		1.018			
Photometric Test Distance: 5 meters															
Max. cd	228	25°C		25°C		25°C		74°C/49°C		74°C/49°C		74°C/49°C			
Vertical	Horizontal	Rated 80Vac		Measured 120Vac		Rated 135Vac		Rated 80Vac		Measured 120Vac		Rated 135Vac		Table 3	
Angle	Angle	Candela	Candela	Candela	Candela	Candela	Candela	Candela	Candela	Candela	Candela	Candela	Candela	Candela	Minimum
Up/Down	Left/Right	Left	Right	Left	Right	Left	Right	Left	Right	Left	Right	Left	Right	Right	Candela
27.5U	7.5	7.9	9.0	8.1	9.1	8.2	9.0	7.8	8.8	7.9	8.9	8.1	9.1		3.6
27.5U	2.5	9.7	10.3	9.9	10.5	9.8	10.4	9.5	10.1	9.7	10.3	9.9	10.5		4.3
22.5U	17.5	6.1	7.1	6.2	7.2	6.1	7.1	6.0	6.9	6.1	7.1	6.2	7.2		3.8
22.5U	12.5	9.3	10.7	9.4	10.9	9.3	10.8	9.1	10.5	9.2	10.7	9.4	10.9		6.4
22.5U	7.5	14.4	15.8	14.7	16.1	14.5	15.9	14.1	15.5	14.4	15.8	14.6	16.1		9.2
22.5U	2.5	19.0	19.9	19.3	20.3	19.0	20.0	18.6	19.5	18.9	19.9	19.2	20.2		11.1
17.5U	22.5	6.2	7.2	6.3	7.3	6.2	7.2	6.1	7.1	6.2	7.2	6.3	7.3		3.8
17.5U	17.5	9.9	11.1	10.1	11.3	9.9	11.1	9.7	10.9	9.9	11.0	10.0	11.2		7.8
17.5U	12.5	17.4	19.3	17.7	19.6	17.5	19.3	17.0	18.9	17.3	19.2	17.7	19.5		13.6
17.5U	7.5	28.8	32.0	29.3	32.6	28.9	32.1	28.2	31.4	28.7	31.9	29.3	32.5		19.7
17.5U	2.5	39.4	41.0	40.1	41.7	39.6	41.1	38.6	40.2	39.3	40.9	40.0	41.6		23.7
12.5U	22.5	9.2	10.4	9.4	10.6	9.3	10.4	9.0	10.2	9.2	10.4	9.4	10.5		6.4
12.5U	17.5	17.3	19.4	17.6	19.7	17.4	19.5	17.0	19.0	17.3	19.3	17.6	19.7		13.6
12.5U	12.5	32.9	35.6	33.5	36.2	33.0	35.7	32.2	34.9	32.8	35.5	33.4	36.1		23.9
12.5U	7.5	52.9	54.1	53.8	55.0	53.1	54.3	51.8	53.0	52.7	53.9	53.6	54.8		34.7
12.5U	2.5	67.9	67.9	69.1	69.1	68.1	68.2	66.5	66.5	67.7	67.7	68.9	68.9		41.8
7.5U	27.5	7.2	8.6	7.3	8.7	7.2	8.6	7.0	8.4	7.2	8.5	7.3	8.7		3.6
7.5U	22.5	15.3	17.8	15.6	18.1	15.4	17.9	15.0	17.4	15.3	17.7	15.6	18.1		9.2
7.5U	17.5	30.7	34.0	31.2	34.6	30.8	34.1	30.0	33.3	30.6	33.9	31.1	34.5		19.7
7.5U	12.5	54.6	56.4	55.5	57.4	54.8	56.6	53.5	55.3	54.4	56.2	55.4	57.3		34.7
7.5U	7.5	78.3	76.9	79.6	78.2	78.5	77.2	76.7	75.3	78.0	76.6	79.4	78.0		50.6
7.5U	2.5	87.9	84.9	89.4	86.3	88.2	85.2	86.1	83.2	87.6	84.6	89.2	86.1		61.1
2.5U	27.5	9.5	11.8	9.7	12.0	9.6	11.8	9.3	11.5	9.5	11.7	9.7	11.9		4.3
2.5U	22.5	23.2	26.6	23.6	27.0	23.3	26.7	22.7	26.0	23.1	26.5	23.6	26.9		11.1
2.5U	17.5	45.6	47.8	46.4	48.6	45.8	48.0	44.7	46.8	45.5	47.6	46.3	48.5		23.7
2.5U	12.5	69.4	71.7	70.6	73.0	69.6	72.0	68.0	70.3	69.1	71.5	70.4	72.8		41.8
2.5U	7.5	86.3	88.9	87.8	90.5	86.6	89.3	84.5	87.1	86.0	88.6	87.5	90.2		61.1
2.5U	2.5	94.3	96.4	96.0	98.1	94.7	96.8	92.4	94.5	94.0	96.1	95.7	97.8		73.9
2.5D	2.5	101.2	99.4	102.9	101.1	101.5	99.8	99.1	97.4	100.8	99.0	102.6	100.8		73.9
2.5D	7.5	89.9	87.6	91.5	89.1	90.2	88.0	88.1	85.8	89.6	87.3	91.2	88.9		61.1
2.5D	12.5	72.8	73.7	74.1	75.0	73.1	74.0	71.4	72.2	72.6	73.4	73.9	74.8		41.8
2.5D	17.5	51.1	54.8	52.0	55.7	51.3	55.0	50.1	53.7	50.9	54.6	51.8	55.6		23.7
2.5D	22.5	25.1	30.0	25.6	30.5	25.2	30.1	24.6	29.4	25.1	29.9	25.5	30.4		11.1
2.5D	27.5	10.3	11.9	10.5	12.1	10.4	11.9	10.1	11.6	10.3	11.8	10.5	12.0		4.3
7.5D	2.5	93.3	91.1	94.9	92.7	93.6	91.4	91.4	89.2	92.9	90.8	94.6	92.4		61.1
7.5D	7.5	83.9	82.6	85.4	84.0	84.3	82.9	82.2	80.9	83.7	82.3	85.2	83.8		50.6
7.5D	12.5	61.3	63.5	62.4	64.6	61.5	63.8	60.0	62.3	61.1	63.3	62.2	64.5		34.7
7.5D	17.5	37.3	41.3	37.9	42.0	37.4	41.5	36.5	40.5	37.2	41.2	37.8	41.9		19.7
7.5D	22.5	18.8	22.2	19.1	22.6	18.9	22.3	18.4	21.7	18.7	22.1	19.1	22.5		9.2
7.5D	27.5	7.5	8.4	7.6	8.6	7.5	8.5	7.3	8.3	7.5	8.4	7.6	8.6		3.6
12.5D	2.5	76.7	78.1	78.0	79.4	77.0	78.4	75.1	76.5	76.4	77.8	77.8	79.2		41.8
12.5D	7.5	61.4	64.1	62.5	65.2	61.7	64.4	60.2	62.8	61.2	63.9	62.3	65.1		34.7
12.5D	12.5	39.7	43.2	40.4	43.9	39.9	43.3	38.9	42.3	39.6	43.0	40.3	43.8		23.9
12.5D	17.5	21.7	23.2	22.1	23.6	21.8	23.3	21.3	22.7	21.7	23.1	22.0	23.5		13.6
12.5D	22.5	9.8	10.8	10.0	11.0	9.9	10.8	9.6	10.6	9.8	10.8	10.0	11.0		6.4
17.5D	2.5	57.1	57.6	58.1	58.6	57.3	57.8	56.0	56.4	56.9	57.4	58.0	58.4		23.7
17.5D	7.5	40.1	40.9	40.8	41.6	40.2	41.0	39.2	40.1	39.9	40.7	40.6	41.5		19.7
17.5D	12.5	23.8	24.4	24.2	24.9	23.9	24.5	23.3	23.9	23.7	24.3	24.1	24.8		13.6
17.5D	17.5	11.0	11.4	11.2	11.6	11.0	11.5	10.8	11.2	11.0	11.4	11.1	11.6		7.8
17.5D	22.5	5.0	5.8	5.1	5.9	5.1	5.8	4.9	5.7	5.0	5.8	5.1	5.9		3.8
22.5D	2.5	27.8	28.3	28.3	28.7	27.9	28.4	27.3	27.7	27.7	28.2	28.2	28.7		11.1
22.5D	7.5	20.2	19.3	20.6	19.6	20.3	19.3	19.8	18.9	20.1	19.2	20.5	19.5		9.2
22.5D	12.5	11.9	11.2	12.1	11.4	11.9	11.2	11.6	10.9	11.8	11.1	12.0	11.3		6.4
22.5D	17.5	6.1	5.7	6.2	5.8	6.1	5.7	5.9	5.6	6.0	5.6	6.1	5.7		3.8
27.5D	2.5	12.2	12.0	12.4	12.2	12.2	12.1	11.9	11.8	12.1	12.0	12.4	12.2		4.3
27.5D	7.5	9.5	9.3	9.7	9.5	9.5	9.3	9.3	9.1	9.5	9.3	9.6	9.4		3.6

Luminous Intensity 6.4.4.1 through 6.4.4.4

Sample	CRT1610241001-002-003					Target Input voltage		Measured Input Voltage		0, 0 Lum. Intensity		Vac Variation Factor		MMLI Factor	
Module	12" Omni Arrow					80Vac		80.3 Vac		95.8 Candela		0.977		0.946	
Color:	Green					120Vac		120.4 Vac		98.1 Candela		1.000			
Lens	Tinted					135Vac		135.0 Vac		97.2 Candela		0.991			
Photometric Test Distance: 5 meters															
Max. cd	228	25°C		25°C		25°C		74°C/49°C		74°C/49°C		74°C/49°C			
Vertical	Horizontal	Rated 80Vac		Measured 120Vac		Rated 135Vac		Rated 80Vac		Measured 120Vac		Rated 135Vac		Table 3	
Angle	Angle	Candela	Candela	Candela	Candela	Candela	Candela	Candela	Candela	Candela	Candela	Candela	Candela	Candela	Minimum
Up/Down	Left/Right	Left	Right	Left	Right	Left	Right	Left	Right	Left	Right	Left	Right	Right	Candela
27.5U	7.5	8.7	9.0	8.9	9.2	8.8	9.1	8.2	8.5	8.4	8.7	8.4	8.6		3.6
27.5U	2.5	10.4	10.5	10.6	10.8	10.5	10.7	9.8	9.9	10.1	10.2	10.0	10.1		4.3
22.5U	17.5	6.4	7.4	6.6	7.5	6.5	7.5	6.1	7.0	6.2	7.1	6.2	7.1		3.8
22.5U	12.5	9.9	10.4	10.1	10.7	10.0	10.6	9.4	9.9	9.6	10.1	9.5	10.0		6.4
22.5U	7.5	15.5	15.6	15.9	16.0	15.7	15.9	14.7	14.8	15.0	15.1	14.9	15.0		9.2
22.5U	2.5	19.9	19.9	20.4	20.4	20.2	20.2	18.8	18.8	19.3	19.3	19.1	19.1		11.1
17.5U	22.5	6.5	7.4	6.6	7.6	6.6	7.5	6.1	7.0	6.3	7.2	6.2	7.1		3.8
17.5U	17.5	10.3	11.3	10.6	11.6	10.5	11.5	9.8	10.7	10.0	11.0	9.9	10.9		7.8
17.5U	12.5	18.4	19.3	18.9	19.8	18.7	19.6	17.4	18.3	17.8	18.7	17.7	18.6		13.6
17.5U	7.5	31.1	31.1	31.8	31.8	31.5	31.5	29.4	29.4	30.1	30.1	29.8	29.8		19.7
17.5U	2.5	40.0	40.5	40.9	41.5	40.5	41.1	37.8	38.3	38.7	39.2	38.4	38.9		23.7
12.5U	22.5	9.3	11.1	9.5	11.4	9.4	11.3	8.8	10.5	9.0	10.8	8.9	10.7		6.4
12.5U	17.5	17.6	20.3	18.0	20.8	17.8	20.6	16.6	19.2	17.0	19.7	16.9	19.5		13.6
12.5U	12.5	33.8	36.7	34.6	37.5	34.3	37.2	32.0	34.7	32.7	35.5	32.4	35.2		23.9
12.5U	7.5	54.0	54.6	55.3	55.9	54.8	55.4	51.1	51.6	52.4	52.9	51.9	52.4		34.7
12.5U	2.5	69.5	66.7	71.1	68.3	70.5	67.7	65.8	63.1	67.3	64.6	66.7	64.0		41.8
7.5U	27.5	7.4	8.9	7.6	9.1	7.5	9.0	7.0	8.4	7.2	8.6	7.1	8.6		3.6
7.5U	22.5	15.0	19.4	15.4	19.9	15.2	19.7	14.2	18.3	14.5	18.8	14.4	18.6		9.2
7.5U	17.5	29.9	36.5	30.6	37.4	30.3	37.0	28.3	34.5	29.0	35.4	28.7	35.0		19.7
7.5U	12.5	55.0	58.2	56.4	59.6	55.8	59.1	52.1	55.1	53.3	56.4	52.8	55.9		34.7
7.5U	7.5	78.5	75.8	80.4	77.6	79.7	76.9	74.3	71.7	76.1	73.4	75.4	72.7		50.6
7.5U	2.5	85.9	86.3	87.9	88.4	87.2	87.6	81.3	81.7	83.2	83.6	82.5	82.9		61.1
2.5U	27.5	9.7	12.4	9.9	12.7	9.8	12.6	9.1	11.8	9.4	12.0	9.3	11.9		4.3
2.5U	22.5	22.2	27.7	22.7	28.3	22.5	28.1	21.0	26.2	21.5	26.8	21.3	26.6		11.1
2.5U	17.5	44.1	49.1	45.1	50.2	44.7	49.8	41.7	46.4	42.7	47.5	42.3	47.1		23.7
2.5U	12.5	68.3	71.1	70.0	72.8	69.3	72.2	64.7	67.3	66.2	68.9	65.6	68.3		41.8
2.5U	7.5	85.6	87.4	87.6	89.4	86.9	88.6	81.0	82.7	82.9	84.6	82.2	83.9		61.1
2.5U	2.5	93.6	95.0	95.8	97.2	95.0	96.3	88.6	89.9	90.7	92.0	89.9	91.2		73.9
2.5D	2.5	97.6	96.4	99.9	98.7	99.0	97.8	92.3	91.2	94.5	93.4	93.7	92.5		73.9
2.5D	7.5	86.7	86.0	88.7	88.0	87.9	87.2	82.0	81.3	84.0	83.3	83.2	82.5		61.1
2.5D	12.5	71.0	71.0	72.7	72.7	72.1	72.0	67.2	67.2	68.8	68.8	68.2	68.2		41.8
2.5D	17.5	50.3	52.2	51.5	53.5	51.0	53.0	47.6	49.4	48.7	50.6	48.3	50.1		23.7
2.5D	22.5	25.6	29.0	26.2	29.7	26.0	29.4	24.3	27.4	24.8	28.1	24.6	27.9		11.1
2.5D	27.5	10.6	11.7	10.9	12.0	10.8	11.9	10.0	11.1	10.3	11.3	10.2	11.2		4.3
7.5D	2.5	90.5	89.8	92.7	91.9	91.8	91.1	85.7	84.9	87.7	87.0	86.9	86.2		61.1
7.5D	7.5	81.5	80.0	83.5	81.9	82.7	81.1	77.1	75.7	79.0	77.5	78.3	76.8		50.6
7.5D	12.5	60.3	61.2	61.7	62.7	61.1	62.1	57.0	57.9	58.4	59.3	57.8	58.8		34.7
7.5D	17.5	36.9	39.2	37.8	40.1	37.4	39.8	34.9	37.1	35.7	38.0	35.4	37.6		19.7
7.5D	22.5	19.2	19.6	19.6	20.0	19.5	19.9	18.1	18.5	18.6	19.0	18.4	18.8		9.2
7.5D	27.5	7.9	7.6	8.1	7.8	8.0	7.7	7.5	7.2	7.6	7.4	7.6	7.3		3.6
12.5D	2.5	73.6	75.4	75.4	77.2	74.7	76.5	69.6	71.3	71.3	73.0	70.7	72.4		41.8
12.5D	7.5	57.8	62.3	59.2	63.8	58.6	63.2	54.7	59.0	56.0	60.4	55.5	59.8		34.7
12.5D	12.5	38.1	41.6	39.0	42.6	38.7	42.2	36.1	39.4	36.9	40.3	36.6	40.0		23.9
12.5D	17.5	21.0	21.4	21.6	21.9	21.4	21.7	19.9	20.3	20.4	20.8	20.2	20.6		13.6
12.5D	22.5	10.1	9.9	10.3	10.1	10.2	10.0	9.5	9.4	9.8	9.6	9.7	9.5		6.4
17.5D	2.5	53.9	53.8	55.2	55.1	54.7	54.6	51.0	50.9	52.2	52.1	51.8	51.6		23.7
17.5D	7.5	36.6	40.7	37.4	41.7	37.1	41.3	34.6	38.5	35.4	39.4	35.1	39.1		19.7
17.5D	12.5	21.6	24.5	22.1	25.1	21.9	24.9	20.4	23.2	20.9	23.7	20.7	23.5		13.6
17.5D	17.5	10.1	10.9	10.4	11.2	10.3	11.1	9.6	10.4	9.8	10.6	9.7	10.5		7.8
17.5D	22.5	5.1	5.5	5.2	5.6	5.1	5.6	4.8	5.2	4.9	5.3	4.9	5.3		3.8
22.5D	2.5	24.9	25.7	25.5	26.3	25.3	26.0	23.6	24.3	24.2	24.9	23.9	24.6		11.1
22.5D	7.5	17.8	18.6	18.3	19.1	18.1	18.9	16.9	17.6	17.3	18.0	17.1	17.9		9.2
22.5D	12.5	10.4	11.3	10.6	11.6	10.5	11.5	9.8	10.7	10.0	10.9	9.9	10.8		6.4
22.5D	17.5	5.4	5.6	5.5	5.8	5.5	5.7	5.1	5.3	5.2	5.5	5.2	5.4		3.8
27.5D	2.5	11.0	11.1	11.2	11.4	11.1	11.3	10.4	10.5	10.6	10.8	10.5	10.7		4.3
27.5D	7.5	8.4	9.1	8.5	9.4	8.5	9.3	7.9	8.6	8.1	8.8	8.0	8.8		3.6

Luminous Intensity 6.4.4.1 through 6.4.4.4

Sample	CRT1611071057-001-001				Target Input voltage		Measured Input Voltage		0, 0 Lum. Intensity		Vac Variation Factor		MMLI Factor		
Module	12" Omni Arrow				80Vac		80.3		Vac		106.1		Candela		
Color:	Green				120Vac		120.1		Vac		106.7		Candela		
Lens	Clear				135Vac		135.4		Vac		108.2		Candela		
Photometric Test Distance: 5 meters															
Max. cd	228	25°C		25°C		25°C		25°C		74°C/49°C		74°C/49°C		74°C/49°C	
Vertical	Horizontal	Rated 80Vac		Measured 120Vac		Rated 135Vac		Rated 80Vac		Measured 120Vac		Rated 135Vac		Table 3	
Angle	Angle	Candela	Candela	Candela	Candela	Candela	Candela	Candela	Candela	Candela	Candela	Candela	Candela	Candela	Minimum
Up/Down	Left/Right	Left	Right	Left	Right	Left	Right	Left	Right	Left	Right	Left	Right	Left	Candela
27.5U	7.5	9.6	9.8	9.7	9.8	9.8	9.9	9.3	9.4	9.4	9.5	9.5	9.6	9.6	3.6
27.5U	2.5	11.5	11.4	11.5	11.5	11.7	11.6	11.0	11.0	11.1	11.1	11.3	11.2	4.3	4.3
22.5U	17.5	7.1	8.2	7.2	8.3	7.3	8.4	6.9	8.0	6.9	8.0	7.0	8.1	3.8	3.8
22.5U	12.5	11.1	11.8	11.2	11.9	11.3	12.0	10.7	11.4	10.8	11.4	10.9	11.6	6.4	6.4
22.5U	7.5	17.6	17.6	17.7	17.7	17.9	17.9	16.9	16.9	17.0	17.0	17.3	17.3	9.2	9.2
22.5U	2.5	22.2	22.1	22.3	22.3	22.6	22.6	21.4	21.3	21.5	21.5	21.8	21.8	11.1	11.1
17.5U	22.5	7.2	8.3	7.2	8.4	7.3	8.5	6.9	8.1	7.0	8.1	7.1	8.2	3.8	3.8
17.5U	17.5	11.5	12.6	11.6	12.7	11.7	12.9	11.1	12.2	11.1	12.3	11.3	12.4	7.8	7.8
17.5U	12.5	21.0	21.6	21.1	21.7	21.4	22.0	20.2	20.8	20.4	21.0	20.6	21.3	13.6	13.6
17.5U	7.5	35.5	34.8	35.7	35.0	36.2	35.5	34.3	33.6	34.5	33.8	34.9	34.2	19.7	19.7
17.5U	2.5	44.9	45.0	45.1	45.2	45.8	45.9	43.3	43.4	43.5	43.6	44.1	44.2	23.7	23.7
12.5U	22.5	10.6	12.5	10.7	12.6	10.8	12.8	10.2	12.1	10.3	12.2	10.4	12.3	6.4	6.4
12.5U	17.5	19.7	22.7	19.8	22.9	20.0	23.2	19.0	21.9	19.1	22.1	19.3	22.4	13.6	13.6
12.5U	12.5	37.5	40.5	37.8	40.7	38.3	41.3	36.2	39.0	36.4	39.3	36.9	39.8	23.9	23.9
12.5U	7.5	59.9	59.6	60.2	59.9	61.0	60.8	57.7	57.5	58.1	57.8	58.9	58.6	34.7	34.7
12.5U	2.5	75.6	73.7	76.1	74.1	77.1	75.2	72.9	71.1	73.4	71.5	74.4	72.5	41.8	41.8
7.5U	27.5	8.2	10.2	8.3	10.3	8.4	10.4	7.9	9.9	8.0	9.9	8.1	10.1	3.6	3.6
7.5U	22.5	16.9	21.6	17.0	21.7	17.2	22.0	16.3	20.8	16.4	20.9	16.6	21.2	9.2	9.2
7.5U	17.5	33.6	40.2	33.8	40.4	34.2	41.0	32.4	38.8	32.6	39.0	33.0	39.5	19.7	19.7
7.5U	12.5	61.3	63.4	61.7	63.8	62.5	64.7	59.1	61.2	59.5	61.5	60.3	62.4	34.7	34.7
7.5U	7.5	86.3	82.7	86.8	83.2	88.0	84.3	83.2	79.8	83.7	80.2	84.8	81.3	50.6	50.6
7.5U	2.5	94.2	95.2	94.7	95.7	96.1	97.1	90.9	91.8	91.4	92.3	92.7	93.6	61.1	61.1
2.5U	27.5	10.7	13.9	10.8	14.0	10.9	14.2	10.3	13.4	10.4	13.5	10.6	13.7	4.3	4.3
2.5U	22.5	24.9	30.4	25.1	30.6	25.4	31.0	24.0	29.3	24.2	29.5	24.5	29.9	11.1	11.1
2.5U	17.5	49.1	53.2	49.4	53.5	50.1	54.2	47.3	51.3	47.6	51.6	48.3	52.3	23.7	23.7
2.5U	12.5	75.7	76.9	76.1	77.4	77.2	78.5	73.0	74.2	73.4	74.6	74.4	75.7	41.8	41.8
2.5U	7.5	94.3	96.6	94.8	97.1	96.1	98.5	90.9	93.1	91.4	93.7	92.7	95.0	61.1	61.1
2.5U	2.5	101.9	105.7	102.5	106.3	103.9	107.8	98.3	101.9	98.9	102.5	100.3	104.0	73.9	73.9
2.5D	2.5	108.2	109.0	108.8	109.6	110.3	111.1	104.3	105.1	104.9	105.7	106.4	107.2	73.9	73.9
2.5D	7.5	97.0	95.2	97.6	95.7	98.9	97.1	93.6	91.8	94.1	92.3	95.4	93.6	61.1	61.1
2.5D	12.5	79.9	79.1	80.4	79.6	81.5	80.7	77.1	76.3	77.5	76.7	78.6	77.8	41.8	41.8
2.5D	17.5	56.2	57.7	56.5	58.0	57.3	58.8	54.2	55.6	54.5	55.9	55.2	56.7	23.7	23.7
2.5D	22.5	28.9	31.3	29.1	31.5	29.5	32.0	27.9	30.2	28.1	30.4	28.5	30.8	11.1	11.1
2.5D	27.5	12.0	12.9	12.0	13.0	12.2	13.2	11.5	12.5	11.6	12.5	11.8	12.7	4.3	4.3
7.5D	2.5	100.6	100.5	101.2	101.1	102.6	102.5	97.1	97.0	97.6	97.5	99.0	98.9	61.1	61.1
7.5D	7.5	90.6	87.6	91.2	88.1	92.4	89.3	87.4	84.5	87.9	85.0	89.1	86.2	50.6	50.6
7.5D	12.5	67.5	65.9	67.9	66.2	68.9	67.2	65.1	63.5	65.5	63.9	66.4	64.8	34.7	34.7
7.5D	17.5	41.3	43.0	41.5	43.2	42.1	43.8	39.8	41.5	40.0	41.7	40.6	42.3	19.7	19.7
7.5D	22.5	21.1	21.2	21.3	21.3	21.5	21.6	20.4	20.5	20.5	20.6	20.8	20.9	9.2	9.2
7.5D	27.5	8.7	8.3	8.8	8.4	8.9	8.5	8.4	8.0	8.4	8.1	8.6	8.2	3.6	3.6
12.5D	2.5	80.8	82.8	81.2	83.3	82.4	84.4	77.9	79.8	78.3	80.3	79.4	81.4	41.8	41.8
12.5D	7.5	63.6	68.5	63.9	68.9	64.8	69.8	61.3	66.1	61.7	66.4	62.5	67.4	34.7	34.7
12.5D	12.5	42.3	45.0	42.6	45.2	43.2	45.9	40.8	43.4	41.0	43.6	41.6	44.2	23.9	23.9
12.5D	17.5	23.4	23.4	23.5	23.6	23.8	23.9	22.5	22.6	22.7	22.7	23.0	23.1	13.6	13.6
12.5D	22.5	11.7	11.1	11.7	11.1	11.9	11.3	11.2	10.7	11.3	10.7	11.5	10.9	6.4	6.4
17.5D	2.5	59.4	60.1	59.8	60.4	60.6	61.3	57.3	57.9	57.7	58.3	58.5	59.1	23.7	23.7
17.5D	7.5	40.8	44.8	41.1	45.1	41.7	45.7	39.4	43.2	39.6	43.5	40.2	44.1	19.7	19.7
17.5D	12.5	24.3	26.5	24.4	26.7	24.8	27.1	23.4	25.6	23.6	25.7	23.9	26.1	13.6	13.6
17.5D	17.5	11.6	12.3	11.7	12.4	11.9	12.5	11.2	11.8	11.3	11.9	11.4	12.1	7.8	7.8
17.5D	22.5	5.9	6.0	5.9	6.1	6.0	6.2	5.6	5.8	5.7	5.9	5.8	5.9	3.8	3.8
22.5D	2.5	28.2	28.9	28.4	29.0	28.8	29.4	27.2	27.9	27.4	28.0	27.8	28.4	11.1	11.1
22.5D	7.5	20.1	21.1	20.2	21.2	20.5	21.5	19.4	20.3	19.5	20.4	19.7	20.7	9.2	9.2
22.5D	12.5	11.7	12.5	11.8	12.6	12.0	12.8	11.3	12.1	11.4	12.2	11.5	12.3	6.4	6.4
22.5D	17.5	6.2	6.4	6.2	6.4	6.3	6.5	5.9	6.1	6.0	6.2	6.1	6.3	3.8	3.8
27.5D	2.5	12.3	12.7	12.4	12.8	12.6	12.9	11.9	12.2	12.0	12.3	12.1	12.5	4.3	4.3
27.5D	7.5	9.4	10.3	9.4	10.3	9.5	10.5	9.0	9.9	9.1	10.0	9.2	10.1	3.6	3.6

Luminous Intensity 6.4.4.1 through 6.4.4.4

Sample	CRT1611071057-001-002				Target Input voltage		Measured Input Voltage		0, 0 Lum. Intensity		Vac Variation Factor		MMLI Factor	
Module	12" Omni Arrow				80Vac		80.3		Vac		104.4		Candela	
Color:	Green				120Vac		120.1		Vac		106.5		Candela	
Lens	Clear				135Vac		135.1		Vac		106.0		Candela	
Photometric Test Distance: 5 meters														
Max. cd	228	25°C		25°C		25°C		74°C/49°C		74°C/49°C		74°C/49°C		
Vertical	Horizontal	Rated 80Vac		Measured 120Vac		Rated 135Vac		Rated 80Vac		Measured 120Vac		Rated 135Vac		Table 3
Angle	Angle	Candela	Candela	Candela	Candela	Candela	Candela	Candela	Candela	Candela	Candela	Candela	Candela	Minimum
Up/Down	Left/Right	Left	Right	Left	Right	Left	Right	Left	Right	Left	Right	Left	Right	Candela
27.5U	7.5	9.6	9.9	9.8	10.2	9.7	10.1	9.3	9.7	9.5	9.8	9.5	9.8	3.6
27.5U	2.5	11.4	11.5	11.6	11.7	11.6	11.7	11.0	11.2	11.3	11.4	11.2	11.3	4.3
22.5U	17.5	7.2	8.1	7.4	8.3	7.3	8.2	7.0	7.9	7.1	8.0	7.1	8.0	3.8
22.5U	12.5	11.4	11.9	11.7	12.2	11.6	12.1	11.1	11.6	11.3	11.8	11.3	11.7	6.4
22.5U	7.5	17.9	17.9	18.2	18.2	18.1	18.1	17.3	17.3	17.7	17.7	17.6	17.6	9.2
22.5U	2.5	22.5	22.7	23.0	23.1	22.9	23.0	21.9	22.0	22.3	22.4	22.2	22.3	11.1
17.5U	22.5	7.3	8.1	7.4	8.2	7.4	8.2	7.1	7.8	7.2	8.0	7.2	8.0	3.8
17.5U	17.5	11.7	12.5	11.9	12.8	11.9	12.7	11.3	12.1	11.6	12.4	11.5	12.3	7.8
17.5U	12.5	21.1	22.0	21.5	22.4	21.4	22.3	20.4	21.3	20.8	21.7	20.7	21.6	13.6
17.5U	7.5	35.1	35.6	35.9	36.3	35.7	36.1	34.1	34.5	34.8	35.2	34.6	35.1	19.7
17.5U	2.5	45.5	46.2	46.4	47.1	46.2	46.9	44.1	44.8	45.0	45.7	44.8	45.5	23.7
12.5U	22.5	10.8	12.3	11.0	12.6	11.0	12.5	10.5	12.0	10.7	12.2	10.7	12.1	6.4
12.5U	17.5	19.6	22.7	20.0	23.2	19.9	23.1	19.0	22.0	19.4	22.5	19.3	22.4	13.6
12.5U	12.5	37.5	40.7	38.3	41.5	38.1	41.3	36.4	39.5	37.1	40.3	37.0	40.1	23.9
12.5U	7.5	60.4	60.7	61.7	61.9	61.4	61.6	58.6	58.9	59.8	60.1	59.5	59.8	34.7
12.5U	2.5	76.8	75.8	78.4	77.3	78.0	76.9	74.5	73.5	76.0	75.0	75.7	74.6	41.8
7.5U	27.5	8.5	10.0	8.6	10.2	8.6	10.2	8.2	9.7	8.4	9.9	8.3	9.9	3.6
7.5U	22.5	17.2	21.8	17.6	22.3	17.5	22.2	16.7	21.2	17.0	21.6	17.0	21.5	9.2
7.5U	17.5	34.2	40.5	34.9	41.3	34.7	41.1	33.2	39.3	33.8	40.1	33.7	39.9	19.7
7.5U	12.5	62.1	65.1	63.3	66.4	63.0	66.1	60.2	63.2	61.4	64.4	61.1	64.1	34.7
7.5U	7.5	86.8	85.4	88.6	87.1	88.2	86.7	84.3	82.8	85.9	84.5	85.5	84.1	50.6
7.5U	2.5	95.0	95.5	96.9	97.4	96.4	96.9	92.2	92.6	94.0	94.5	93.6	94.0	61.1
2.5U	27.5	10.9	13.6	11.2	13.9	11.1	13.9	10.6	13.2	10.8	13.5	10.8	13.4	4.3
2.5U	22.5	25.5	31.3	26.1	31.9	25.9	31.7	24.8	30.3	25.3	30.9	25.2	30.8	11.1
2.5U	17.5	50.1	55.3	51.1	56.4	50.9	56.1	48.6	53.6	49.6	54.7	49.4	54.4	23.7
2.5U	12.5	77.3	79.7	78.9	81.3	78.5	80.9	75.0	77.3	76.5	78.8	76.2	78.5	41.8
2.5U	7.5	94.5	96.5	96.4	98.4	95.9	98.0	91.6	93.6	93.5	95.5	93.0	95.0	61.1
2.5U	2.5	102.3	104.2	104.4	106.3	103.9	105.8	99.3	101.1	101.3	103.1	100.8	102.6	73.9
2.5D	2.5	107.2	105.7	109.4	107.8	108.9	107.3	104.0	102.5	106.1	104.6	105.6	104.1	73.9
2.5D	7.5	96.6	93.6	98.6	95.5	98.1	95.1	93.7	90.8	95.6	92.6	95.2	92.2	61.1
2.5D	12.5	79.6	78.5	81.2	80.1	80.8	79.7	77.3	76.1	78.8	77.7	78.4	77.3	41.8
2.5D	17.5	55.8	58.2	57.0	59.4	56.7	59.1	54.2	56.4	55.3	57.6	55.0	57.3	23.7
2.5D	22.5	28.8	33.1	29.4	33.7	29.3	33.6	28.0	32.1	28.5	32.7	28.4	32.6	11.1
2.5D	27.5	11.9	13.1	12.2	13.4	12.1	13.3	11.6	12.7	11.8	13.0	11.8	12.9	4.3
7.5D	2.5	99.0	99.1	101.0	101.1	100.5	100.6	96.1	96.1	98.0	98.1	97.5	97.6	61.1
7.5D	7.5	88.9	87.1	90.7	88.9	90.3	88.5	86.2	84.5	88.0	86.2	87.6	85.8	50.6
7.5D	12.5	67.0	67.0	68.3	68.4	68.0	68.0	65.0	65.0	66.3	66.3	66.0	66.0	34.7
7.5D	17.5	41.6	44.4	42.5	45.3	42.3	45.0	40.4	43.0	41.2	43.9	41.0	43.7	19.7
7.5D	22.5	21.3	23.2	21.8	23.6	21.7	23.5	20.7	22.5	21.1	22.9	21.0	22.8	9.2
7.5D	27.5	8.7	8.9	8.8	9.1	8.8	9.0	8.4	8.6	8.6	8.8	8.5	8.7	3.6
12.5D	2.5	82.7	82.4	84.3	84.1	83.9	83.7	80.2	80.0	81.8	81.6	81.4	81.2	41.8
12.5D	7.5	65.2	69.2	66.5	70.6	66.2	70.3	63.2	67.2	64.5	68.5	64.2	68.2	34.7
12.5D	12.5	43.5	47.1	44.4	48.1	44.2	47.9	42.2	45.7	43.1	46.7	42.9	46.4	23.9
12.5D	17.5	23.9	25.0	24.4	25.5	24.3	25.4	23.2	24.3	23.7	24.8	23.6	24.7	13.6
12.5D	22.5	11.3	11.5	11.5	11.7	11.5	11.7	10.9	11.2	11.2	11.4	11.1	11.3	6.4
17.5D	2.5	61.3	61.5	62.6	62.7	62.3	62.4	59.5	59.6	60.7	60.8	60.4	60.6	23.7
17.5D	7.5	41.9	46.1	42.7	47.1	42.5	46.8	40.6	44.8	41.4	45.7	41.3	45.4	19.7
17.5D	12.5	25.2	28.0	25.7	28.6	25.5	28.5	24.4	27.2	24.9	27.8	24.8	27.6	13.6
17.5D	17.5	11.7	12.7	11.9	12.9	11.9	12.9	11.4	12.3	11.6	12.5	11.5	12.5	7.8
17.5D	22.5	5.7	6.3	5.8	6.4	5.8	6.4	5.5	6.1	5.6	6.2	5.6	6.2	3.8
22.5D	2.5	29.9	30.6	30.5	31.2	30.4	31.1	29.0	29.7	29.6	30.3	29.5	30.1	11.1
22.5D	7.5	21.3	22.3	21.8	22.8	21.7	22.7	20.7	21.6	21.1	22.1	21.0	22.0	9.2
22.5D	12.5	12.4	13.4	12.7	13.6	12.6	13.6	12.1	13.0	12.3	13.2	12.3	13.2	6.4
22.5D	17.5	6.4	6.7	6.6	6.8	6.5	6.8	6.2	6.5	6.4	6.6	6.3	6.6	3.8
27.5D	2.5	13.1	13.4	13.4	13.7	13.3	13.6	12.7	13.0	13.0	13.3	12.9	13.2	4.3
27.5D	7.5	9.9	10.9	10.1	11.1	10.1	11.0	9.6	10.5	9.8	10.7	9.8	10.7	3.6

Luminous Intensity 6.4.4.1 through 6.4.4.4

Sample	CRT1611071057-003-001					Target Input voltage		Measured Input Voltage		0, 0 Lum. Intensity		Vac Variation Factor		MMLI Factor	
Module	12" Omni Arrow					80Vac		80.4		Vac		103.2		Candela	
Color:	Green					120Vac		120.2		Vac		104.0		Candela	
Lens	Clear					135Vac		135.3		Vac		103.1		Candela	
Photometric Test Distance: 5 meters															
Max. cd	228	25°C		25°C		25°C		25°C		74°C/49°C		74°C/49°C		74°C/49°C	
Vertical	Horizontal	Rated 80Vac		Measured 120Vac		Rated 135Vac		Rated 80Vac		Measured 120Vac		Rated 135Vac		Table 3	
Angle	Angle	Candela	Candela	Candela	Candela	Candela	Candela	Candela	Candela	Candela	Candela	Candela	Candela	Candela	Minimum
Up/Down	Left/Right	Left	Right	Left	Right	Left	Right	Left	Right	Left	Right	Left	Right	Left	Candela
27.5U	7.5	9.9	9.6	10.0	9.7	9.9	9.6	9.4	9.0	9.4	9.1	9.4	9.0	9.0	3.6
27.5U	2.5	11.6	11.3	11.7	11.4	11.6	11.3	10.9	10.7	11.0	10.8	10.9	10.7	10.7	4.3
22.5U	17.5	7.5	8.0	7.5	8.1	7.5	8.0	7.1	7.5	7.1	7.6	7.1	7.5	7.5	3.8
22.5U	12.5	11.7	11.5	11.8	11.6	11.7	11.5	11.1	10.9	11.1	10.9	11.0	10.8	10.8	6.4
22.5U	7.5	18.3	17.3	18.5	17.5	18.3	17.3	17.3	16.4	17.4	16.5	17.3	16.3	16.3	9.2
22.5U	2.5	22.9	22.2	23.1	22.4	22.9	22.2	21.6	21.0	21.8	21.1	21.6	20.9	20.9	11.1
17.5U	22.5	7.6	7.9	7.6	8.0	7.6	7.9	7.1	7.5	7.2	7.5	7.1	7.5	7.5	3.8
17.5U	17.5	11.9	12.1	12.0	12.2	11.9	12.1	11.3	11.4	11.3	11.5	11.2	11.4	11.4	7.8
17.5U	12.5	21.5	21.3	21.7	21.4	21.5	21.2	20.3	20.1	20.4	20.2	20.3	20.0	20.0	13.6
17.5U	7.5	36.9	34.0	37.2	34.2	36.8	33.9	34.8	32.0	35.1	32.3	34.8	32.0	32.0	19.7
17.5U	2.5	45.8	44.8	46.2	45.1	45.8	44.7	43.2	42.2	43.6	42.6	43.2	42.2	42.2	23.7
12.5U	22.5	10.8	12.2	10.9	12.3	10.8	12.1	10.2	11.5	10.3	11.6	10.2	11.5	11.5	6.4
12.5U	17.5	20.1	22.4	20.2	22.6	20.0	22.4	18.9	21.2	19.1	21.3	18.9	21.1	21.1	13.6
12.5U	12.5	37.8	40.1	38.1	40.4	37.8	40.0	35.7	37.8	35.9	38.1	35.6	37.8	37.8	23.9
12.5U	7.5	60.0	59.7	60.5	60.2	60.0	59.7	56.6	56.4	57.1	56.8	56.6	56.3	56.3	34.7
12.5U	2.5	75.8	73.4	76.4	73.9	75.7	73.3	71.5	69.2	72.0	69.7	71.4	69.1	69.1	41.8
7.5U	27.5	8.5	9.9	8.5	10.0	8.5	9.9	8.0	9.4	8.0	9.5	8.0	9.4	9.4	3.6
7.5U	22.5	17.0	21.8	17.1	21.9	17.0	21.8	16.0	20.5	16.2	20.7	16.0	20.5	20.5	9.2
7.5U	17.5	33.5	40.9	33.8	41.2	33.5	40.9	31.6	38.6	31.9	38.9	31.6	38.5	38.5	19.7
7.5U	12.5	61.6	63.3	62.1	63.8	61.6	63.2	58.1	59.7	58.6	60.1	58.1	59.6	59.6	34.7
7.5U	7.5	87.4	81.7	88.1	82.3	87.3	81.6	82.5	77.1	83.1	77.7	82.4	77.0	77.0	50.6
7.5U	2.5	94.0	93.3	94.7	94.1	93.9	93.2	88.6	88.0	89.3	88.7	88.5	87.9	87.9	61.1
2.5U	27.5	10.8	13.2	10.9	13.3	10.8	13.2	10.2	12.4	10.3	12.5	10.2	12.4	12.4	4.3
2.5U	22.5	24.7	30.6	24.9	30.9	24.6	30.6	23.3	28.9	23.5	29.1	23.2	28.8	28.8	11.1
2.5U	17.5	48.9	55.0	49.3	55.4	48.8	55.0	46.1	51.9	46.5	52.3	46.1	51.8	51.8	23.7
2.5U	12.5	76.0	77.4	76.6	78.0	75.9	77.3	71.7	73.0	72.2	73.6	71.6	72.9	72.9	41.8
2.5U	7.5	94.6	94.3	95.3	95.0	94.5	94.2	89.2	89.0	89.9	89.6	89.1	88.9	88.9	61.1
2.5U	2.5	101.8	102.2	102.6	103.0	101.7	102.1	96.0	96.4	96.8	97.2	95.9	96.3	96.3	73.9
2.5D	2.5	104.8	103.7	105.6	104.5	104.7	103.6	98.8	97.8	99.6	98.6	98.8	97.7	97.7	73.9
2.5D	7.5	94.1	92.1	94.9	92.8	94.0	92.0	88.8	86.8	89.5	87.5	88.7	86.8	86.8	61.1
2.5D	12.5	79.0	77.2	79.6	77.8	78.9	77.2	74.5	72.9	75.1	73.4	74.4	72.8	72.8	41.8
2.5D	17.5	56.8	56.7	57.2	57.1	56.7	56.6	53.5	53.4	54.0	53.9	53.5	53.4	53.4	23.7
2.5D	22.5	29.5	31.4	29.7	31.7	29.5	31.4	27.8	29.7	28.1	29.9	27.8	29.6	29.6	11.1
2.5D	27.5	11.7	12.4	11.8	12.5	11.7	12.4	11.1	11.7	11.1	11.8	11.0	11.7	11.7	4.3
7.5D	2.5	98.2	97.8	99.0	98.6	98.1	97.7	92.6	92.3	93.3	93.0	92.5	92.2	92.2	61.1
7.5D	7.5	89.6	86.9	90.3	87.6	89.6	86.8	84.6	82.0	85.2	82.6	84.5	81.9	81.9	50.6
7.5D	12.5	66.9	65.8	67.4	66.3	66.8	65.7	63.1	62.0	63.6	62.5	63.1	62.0	62.0	34.7
7.5D	17.5	41.6	42.5	41.9	42.8	41.5	42.4	39.2	40.1	39.5	40.4	39.2	40.0	40.0	19.7
7.5D	22.5	21.7	20.7	21.9	20.9	21.7	20.7	20.5	19.5	20.7	19.7	20.5	19.5	19.5	9.2
7.5D	27.5	8.9	8.0	8.9	8.0	8.9	8.0	8.4	7.5	8.4	7.6	8.4	7.5	7.5	3.6
12.5D	2.5	81.4	82.3	82.1	82.9	81.3	82.2	76.8	77.6	77.4	78.2	76.7	77.6	77.6	41.8
12.5D	7.5	64.5	68.8	65.0	69.4	64.4	68.8	60.8	64.9	61.3	65.4	60.8	64.9	64.9	34.7
12.5D	12.5	42.8	45.8	43.1	46.2	42.8	45.8	40.4	43.2	40.7	43.6	40.3	43.2	43.2	23.9
12.5D	17.5	24.3	23.8	24.4	24.0	24.2	23.8	22.9	22.5	23.1	22.6	22.9	22.4	22.4	13.6
12.5D	22.5	11.8	10.7	11.9	10.8	11.8	10.7	11.1	10.1	11.2	10.2	11.1	10.1	10.1	6.4
17.5D	2.5	60.0	60.4	60.5	60.8	60.0	60.3	56.6	56.9	57.1	57.4	56.6	56.9	56.9	23.7
17.5D	7.5	41.3	46.5	41.7	46.9	41.3	46.5	39.0	43.9	39.3	44.2	39.0	43.8	43.8	19.7
17.5D	12.5	24.2	28.0	24.4	28.3	24.2	28.0	22.8	26.5	23.0	26.7	22.8	26.4	26.4	13.6
17.5D	17.5	11.7	12.4	11.8	12.5	11.7	12.4	11.0	11.7	11.1	11.8	11.0	11.7	11.7	7.8
17.5D	22.5	5.8	6.0	5.8	6.1	5.8	6.0	5.5	5.7	5.5	5.7	5.5	5.7	5.7	3.8
22.5D	2.5	29.5	30.1	29.7	30.3	29.5	30.1	27.8	28.4	28.1	28.6	27.8	28.4	28.4	11.1
22.5D	7.5	21.1	22.4	21.2	22.5	21.0	22.3	19.9	21.1	20.0	21.3	19.9	21.1	21.1	9.2
22.5D	12.5	11.9	13.6	12.0	13.7	11.9	13.6	11.2	12.8	11.3	12.9	11.2	12.8	12.8	6.4
22.5D	17.5	6.1	6.8	6.1	6.9	6.1	6.8	5.8	6.4	5.8	6.5	5.7	6.4	6.4	3.8
27.5D	2.5	12.7	13.4	12.8	13.6	12.6	13.4	11.9	12.7	12.0	12.8	11.9	12.7	12.7	4.3
27.5D	7.5	9.6	11.1	9.7	11.2	9.6	11.1	9.1	10.5	9.1	10.5	9.1	10.4	10.4	3.6

Complies: ☒ YES ☐ NO

Tested By:	Matthew Benninger	Signature or initials:	mb	Comp. Date	12/16/2016,12/18/2016
Reviewed By:	cwm	Signature or initials:	<i>cwm</i>		
Test Equipment Used:	15,16,17,18				
Amb (°C):	25	RH%:	27		

Lens Abrasion Resistance 6.4.5.2

A lens was mounted in the abrasion test fixture with the lens facing upwards. An abrading pad was cycled back and forth (1 cycle) for twelve cycles at $10\text{cm} \pm 2\text{cm}$ per second over the test surface of the lens. The abrading pad shall not be less than $2.5\text{cm} \pm 0.1\text{cm}$ square, constructed of 0000 steel wool rubber cemented to a rigid base shaped to the contour of the lens. The "grain" of the pad was perpendicular to the direction of motion. The abrading pad support was equal in size to the pad and the center of the support surface was within $\pm 2\text{mm}$ of parallel to the lens surface. The density of the abrading pad was such that when the pad was mounted to its support and is resting unweight on the lens, the base of the pad was no closer than 3.2mm to the lens at its closest point. When mounted on its support and resting on the lens, the abrading pad was weighted such that a pad pressure of $14\text{kPa} \pm 1\text{kPa}$ exists at the center and perpendicular to the face of the lens. A pivot was used to follow the contour of the lens.

Results

A single intensity point was measured before and after the abrasion. In all samples tested the abraded lens intensity measurement was at least 90% of the un-abraded lens intensity measurement.

12" Green Omni Arrow Tinted			
Sample	Pre Abrasion	Post Abrasion	Percentage
CRT1610241001-003-004	95.7	94.2	98.5
CRT1610241001-003-005	100.3	99.5	99.2
CRT1610241001-002-003	98.1	96.0	97.9

12" Green Omni Arrow Clear			
Sample	Pre Abrasion	Post Abrasion	Percentage
CRT1611071057-001-001	106.7	104.4	97.8
CRT1611071057-001-002	106.5	105.8	99.3
CRT1611071057-003-001	104.0	103.3	99.3

Measured Voltage:	120.2	Vac		
Measured Weight:	11	lbs		
Abrasion Pad	5.5	Sq. In		
Pad Pressure	2.0	psi	13.8	Kpa

Complies: ☒ YES ☐ NO

Tested By:	Matthew Benninger	Signature or initials:	mb	Comp. Date	12/20/16
Reviewed By:	cwm	Signature or initials:	<i>AM</i>		
Test Equipment Used:	15,16,17,18,19				
Amb (°C):	23	RH%	28		

Luminance Uniformity

Luminance measurements were taken at nine locations across the signal face. A spot size of 1/2 inch was used. The luminance meter was translated from side to side and up and down remaining normal to the sample surface. The measurements were used to determine luminance uniformity. The measurements were taken after operating on the same duty cycle used during the photometric test.

Results

The ratio between the maximum and the minimum luminance was less than 10 to 1. Data follows.

12" Green Omni Arrow Tinted			
Sample	CRT1610241001-003-004	CRT1610241001-003-005	CRT1610241001-002-003
Location	Luminance	Luminance	Luminance
1	420	445	523
2	618	629	641
3	691	710	658
4	556	577	597
5	384	435	456
6	408	440	403
7	583	635	547
8	961	940	674
9	464	530	666
Average	565	593	574
Intensity Ratio	2.5 to 1.0	2.2 to 1.0	1.7 to 1.0

Note: Neutral density filter 1.0 was used for luminance measurements and are relative.

12" Green Omni Arrow Clear			
Sample	CRT1611071057-001-001	CRT1611071057-001-002	CRT1611071057-003-001
Location	Luminance	Luminance	Luminance
1	461	320	346
2	741	661	627
3	691	592	690
4	641	769	734
5	523	301	333
6	378	423	355
7	582	535	538
8	690	1130	963
9	756	519	642
Average	607	583	581
Intensity Ratio	2.0 to 1.0	3.8 to 1.0	2.9 to 1.0

Note: Neutral density filter 1.0 was used for luminance measurements and are relative.

Luminance measurements are in cd/m²

Same 60 minute warm-up used for luminous intensity

Test distance is 9.5 feet with 1/4 degree aperture using the PR 740

Measured Voltage: 119.9 - 120.1 Vac

Complies: ☒ YES ☐ NO

Tested By:	Kurt Dobler	Signature or initials:	kfd	Comp. Date	11/17/16
Reviewed By:	cwm	Signature or initials:	<i>cwm</i>		
Test Equipment Used:	2,3,10,11				
Amb (°C):	23.1	RH%	30		

Chromaticity 6.4.4.6

The chromaticity measurements were performed on the submitted LED Traffic Signal Modules with the spectroradiometer. The samples were operated at nominal input voltage and ambient temperature during the measurements. The measurements were taken from 380-780nm in 2nm increments.

The chromaticity measurements were taken at nine locations across the signal face. A spot size of 1/2 inch was used with the samples operating on the same duty cycle used during the photometric test. The spectroradiometer was translated from side to side and up and down remaining normal to the sample surface. The average of the measurements are recorded.

Results



12" Omni Arrow		Chromaticity Coordinates	
Color	Sample	x	y
Green (Tinted)	CRT1610241001-003-004	0.075	0.538
	CRT1610241001-003-005	0.076	0.551
	CRT1610241001-002-003	0.074	0.541

12" Omni Arrow		Chromaticity Coordinates	
Color	Sample	x	y
Green (Clear)	CRT1611071057-001-001	0.084	0.536
	CRT1611071057-001-002	0.085	0.537
	CRT1611071057-003-001	0.083	0.529

The chromaticity measurements pass the requirements of the referenced specification.

Measured Voltage:	119.9 - 120.1	Vac
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Complies: ☒ YES ☐ NO

Tested By:	Kurt Dobler/John Robins	Signature or initials:	kfd 	Comp. Date	11/17/16
Reviewed By:	cwm	Signature or initials:			
Test Equipment Used:	2,3,10,11				
Amb (°C):	23.1	RH%	30		

Color Uniformity 6.4.4.7

Three samples of each model were tested. Nine color measurements were taken at different locations on the traffic signal face. The measurements were taken after operating on the same duty cycle used during the photometric test. The dominant wave length was found using the measured (x, y) coordinates and table 3.29 of "Color Science" by Wyszecki & Stiles.



Results

12" Green Omni Arrow Tinted									
Sample	CRT1610241001-003-004			CRT1610241001-003-005			CRT1610241001-002-003		
Location	x	y	Dominant	x	y	Dominant	x	y	Dominant
1	0.075	0.539	502	0.077	0.552	503	0.075	0.547	503
2	0.075	0.541	503	0.077	0.556	503	0.075	0.543	503
3	0.075	0.539	502	0.076	0.552	503	0.075	0.547	503
4	0.075	0.536	502	0.076	0.550	503	0.075	0.540	502
5	0.076	0.548	503	0.075	0.555	503	0.075	0.544	503
6	0.076	0.537	502	0.077	0.552	503	0.076	0.544	503
7	0.075	0.530	502	0.076	0.548	503	0.074	0.535	502
8	0.075	0.542	503	0.075	0.548	503	0.076	0.548	502
9	0.075	0.531	502	0.078	0.545	503	0.068	0.520	501
Average	0.075	0.538	502	0.076	0.551	503	0.074	0.541	502

12" Green Omni Arrow Clear									
Sample	CRT1611071057-001-001			CRT1611071057-001-002			CRT1611071057-003-001		
Location	x	y	Dominant	x	y	Dominant	x	y	Dominant
1	0.084	0.545	503	0.083	0.539	503	0.082	0.536	503
2	0.084	0.537	503	0.084	0.539	503	0.084	0.531	502
3	0.085	0.542	503	0.084	0.538	503	0.084	0.533	502
4	0.084	0.538	503	0.084	0.538	503	0.083	0.528	502
5	0.083	0.538	503	0.084	0.545	503	0.082	0.530	502
6	0.085	0.535	503	0.084	0.530	502	0.084	0.527	502
7	0.084	0.527	502	0.085	0.528	502	0.083	0.519	502
8	0.082	0.529	502	0.086	0.528	502	0.083	0.517	502
9	0.086	0.537	503	0.087	0.552	504	0.084	0.545	503
Average	0.084	0.536	503	0.085	0.537	503	0.083	0.529	502

Measured Voltage:	119.9 - 120.1	Vac
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Complies:	<input checked="" type="checkbox"/> YES	<input type="checkbox"/> NO
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Tested By:	Kurt Dobler/John Robins	Signature or initials:	kfd 	Comp. Date	11/17/16
Reviewed By:	cwm	Signature or initials:			
Test Equipment Used:	2,3,10,11				
Amb (°C):	23.1	RH%	30		

Current Consumption 6.4.6.1

Three samples were measured for current flow in amperes. The measured current values are supplied for comparison of Product Quality Assurance current measurements on production modules. Current measurements were taken at start up.

Results

Measurements are in (mA)

12" Green Omni Arrow			
Sample	-40°C	25°C	74°C
CRT1610241001-003-001	75.0	64.7	61.6
CRT1610241001-003-002	75.7	66.0	62.8
CRT1610241001-003-003	75.9	64.9	62.3

The current consumption was not in excess of 120% of the label current values for an ambient temperature of 25°C.

Measured Voltage:	120.1	Vac
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Complies: ☒ YES ☐ NO

Tested By:	John Robins	Signature or initials:	<i>JR</i>	Comp. Date	11/10/16
Reviewed By:	cwm	Signature or initials:	<i>cwm</i>		
Test Equipment Used:	2,8				
Amb (°C):	na	RH%	na		

Low Voltage Turn Off 6.4.6.2

Three samples were measured to ensure compliance with the low voltage turn-off requirement. Each sample was fully illuminated at the nominal operating voltage. The applied voltage was then reduced to the point where there was no visible illumination.

Results

There was no visible illumination when the applied voltage was less than 35Vac RMS.

12" Green Omni Arrow	
Sample	Low Voltage Turn Off (Vac RMS)
CRT1610241001-003-001	64.8
CRT1610241001-003-002	64.3
CRT1610241001-003-003	64.7

Complies: ☒ YES ☐ NO

Tested By:	Kurt Dobler	Signature or initials:	kfd	Comp. Date	11/9/16
Reviewed By:	cwm	Signature or initials:	<i>cwm</i>		
Test Equipment Used:	1,9				
Amb (°F):	72	RH%	37		

Turn-On/Turn-Off Times 6.4.6.3

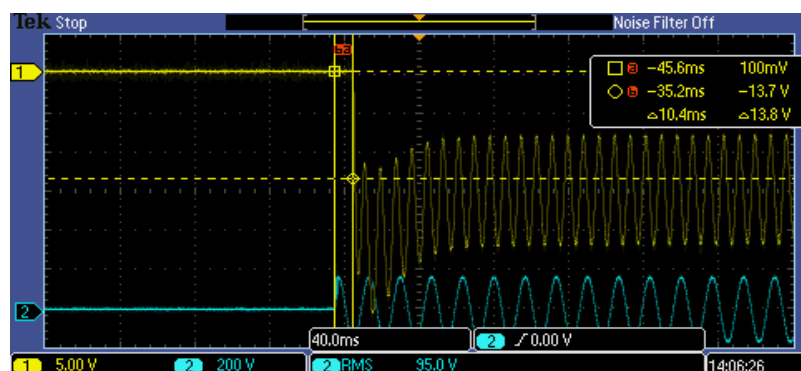
Three samples were measured to ensure compliance with the turn-on and turn-off requirements. The measurements were conducted using a two channel oscilloscope to measure the time delay between when the samples are energized at 120 Vac RMS and when the light output reaches 90% of full output. The same test equipment was used to measure the time delay between when the sample is de-energized and when the light output reaches 0% of full output.

Results

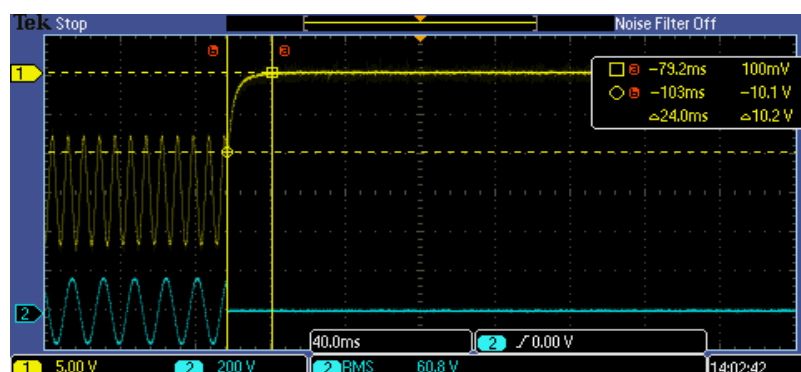
12" Green Omni Arrow		
Sample	Turn On	Turn Off
CRT1610241001-003-001	10.4	24.0
CRT1610241001-003-002	11.2	19.2
CRT1610241001-003-003	13.6	20.0

The "on" time and "off" time were within the 75ms requirement on all samples tested.

Sample Turn On Time



Sample Turn Off Time



Measured Voltage: 120 Vac

Complies: ☒ YES ☐ NO

Tested By:	John Robins	Signature or initials:	<i>JR</i>	Comp. Date:	12/6/16
Reviewed By:	cwm	Signature or initials:	<i>cwm</i>		
Test Equipment Used:	9,13,14				
Amb (°f):	72	RH%	27		

Transient Voltage Immunity 6.4.6.4

Three samples were subjected to 3 positive and 3 negative 1000V 7.5 joule pulses across their input leads at a rate of 0.5 pps in accordance with NEMA TS 2-2003 section 2.1.8. The pulses were the discharge from a 15µF capacitor. The devices were then energized with rated voltage to verify proper operation.

Results

The signal modules withstood the applications of the transient voltage without damage or operational deterioration.

12" Green Omni Arrow			
Sample	3 Positive Pulses	3 Negative Pulses	Results
CRT1610241001-003-001	x	x	Pass
CRT1610241001-003-002	x	x	Pass
CRT1610241001-003-003	x	x	Pass

Measured Voltage:	1000	Vdc
Measured Capacitance:	15.8 - 16.6	µF

Complies: ☒ YES ☐ NO

Tested By:	Kurt Dobler	Signature or initials:	kfd	Comp. Date	12/8/16
Reviewed By:	1,9	Signature or initials:	<i>AM</i>		
Test Equipment Used:	cwm				
Amb (°f):	72	RH%	30		

Electronic Noise 6.4.6.5

Three LED traffic signal modules were operated at 120 VAC/60Hz throughout the test. Emissions measurements were taken to compare values to applicable requirements.

Results

The emissions complied with the requirements of the referenced specification. The testing was performed at our Oakdale, MN office. See report: 102785964MIN-014G

Complies: ☒ YES ☐ NO

Tested By:	Randy Libersky	Signature or initials:	See Report	Comp. Date	12/27/16
Reviewed By:	Norman Shpilsher	Signature or initials:	See Report		
Test Equipment Used:	See Report				
Amb (°C):	See Report	RH%	See Report		

Power Factor & Total Harmonic Distortion 6.4.6.6 & 6.4.6.7



Three tinted samples of each model were measured for power factor and total harmonic distortion. A commercially available power analyzer was used to perform these measurements.

Results

12" Green Omni Arrow						
Sample	Voltage	Current (mA)	Power (W)	Power Factor	THD V%	THD I%
CRT1610241001-003-001	120.0	62.8	7.3	0.96	0.82	14.7
CRT1610241001-003-002	120.1	64.2	7.4	0.96	0.81	14.5
CRT1610241001-003-003	120.1	63.4	7.3	0.96	0.77	14.6
Requirement	NA	NA	NA	≥ 0.90	≤ 20%	≤ 20%

Measurements taken after a minimum 60 minute warmup.

Complies: ☒ YES ☐ NO

Tested By:	John Robins	Signature or initials:		Comp. Date	11/8/16
Reviewed By:	cwm	Signature or initials:			
Test Equipment Used:	8,9				
Amb (°f):	72	RH%	28		

Load Switch Compatibility 6.4.7.1

Three samples were connected to a variable AC voltage supply. The sample was monitored for sufficient current draw to ensure proper load switch operation while the voltage is varied from 80V rms to 135 V rms.

Results

The load switch data is provided to the client to determine if the current draw is acceptable. The referenced ITE specification does not list a minimum current draw requirement. As a result, the Caltrans Standard Specifications dated 2010, Section 86-4.01D(2)(a) must be followed listing a minimum power consumption requirement of 5 watts for 12" traffic signal modules.

12" Green Omni Arrow		
Sample	80 Vrms	135 Vrms
CRT1610241001-003-001	89.6	64.0
CRT1610241001-003-002	91.3	64.3
CRT1610241001-003-003	90.3	63.1



Current measurements are in mA

12" Green Omni Arrow		
Sample	80 Vrms	135 Vrms
CRT1610241001-003-001	6.9	7.6
CRT1610241001-003-002	7.0	7.7
CRT1610241001-003-003	6.9	7.6

Power measurements are in watts.

Measured Voltage 80Vac:	80.1	Vac
Measured Voltage 135Vac:	134.9	Vac

Complies: ☒ YES ☐ NO

Tested By:	John Robins	Signature or initials:		Comp. Date	11/9/16
Reviewed By:	cwm	Signature or initials:			
Test Equipment Used:	8,9				
Amb (°f):	70	RH%	38		

Off State Voltage Decay 6.4.7.2

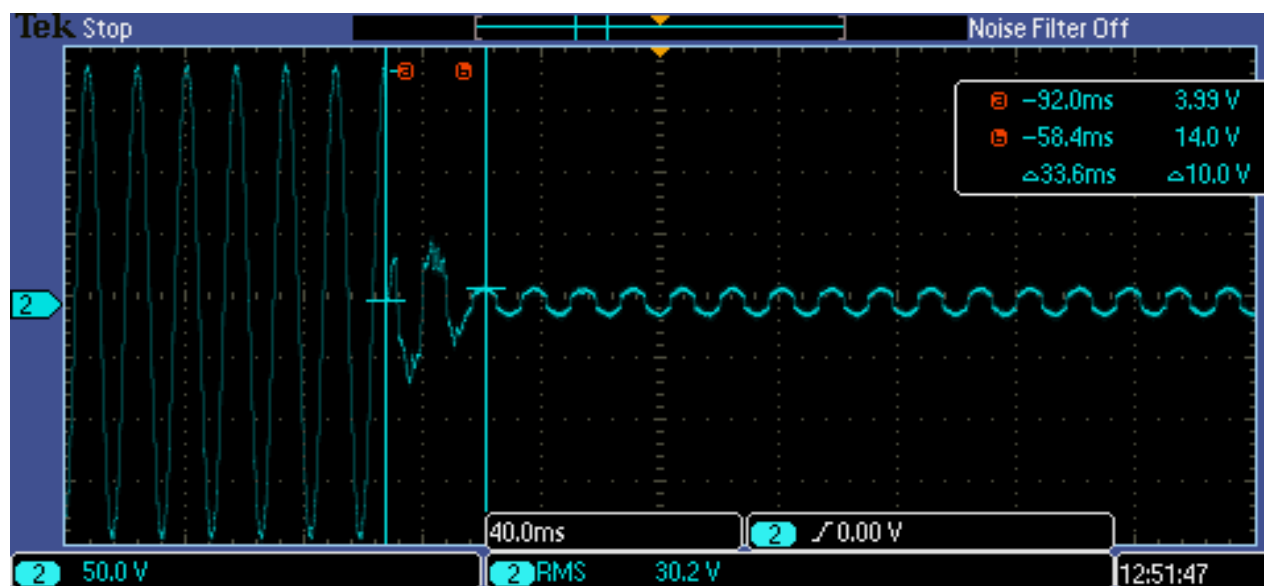
Three samples were operated from a 135V AC voltage supply. A 19.5 k-ohm resistor was wired in series in the hot line between the LED signal monitor and the AC power supply. A single-pole-single-throw switch was wired in parallel across the 19.5 k-ohm resistor. A 220 k-ohm shunt resistor was wired between the hot line connection and the neutral line connection on the LED signal module. The single-pole-single-throw switch was closed, shorting out the 19.5 k-ohm resistor, allowing the AC power supply to illuminate the LED signal module. Next the switch was opened and the voltage across the 220 k-ohm shunt resistor was measured for a decay to a value equal to or less than 10V rms within a time period equal to or less than 100 milliseconds. The test was repeated a sufficient number of times to ensure testing occurs at the peak of the AC line voltage cycle.

Results

12" Green Omni Arrow	
sample	Decay Time (mS)
CRT1610241001-003-001	32.8
CRT1610241001-003-002	32.0
CRT1610241001-003-003	33.6

In all samples measured the decay time was less than 100mS.

Sample Screen Shot



Measured Voltage: 135 Vac

Complies: ☒ YES ☐ NO

Tested By:	John Robins	Signature or initials:	<i>JR</i>	Comp. Date	12/7/16
Reviewed By:	cwm	Signature or initials:	<i>cwm</i>		
Test Equipment Used:	9,13,14				
Amb (°f):	72	RH%	29		

Failed State Impedance 6.4.8

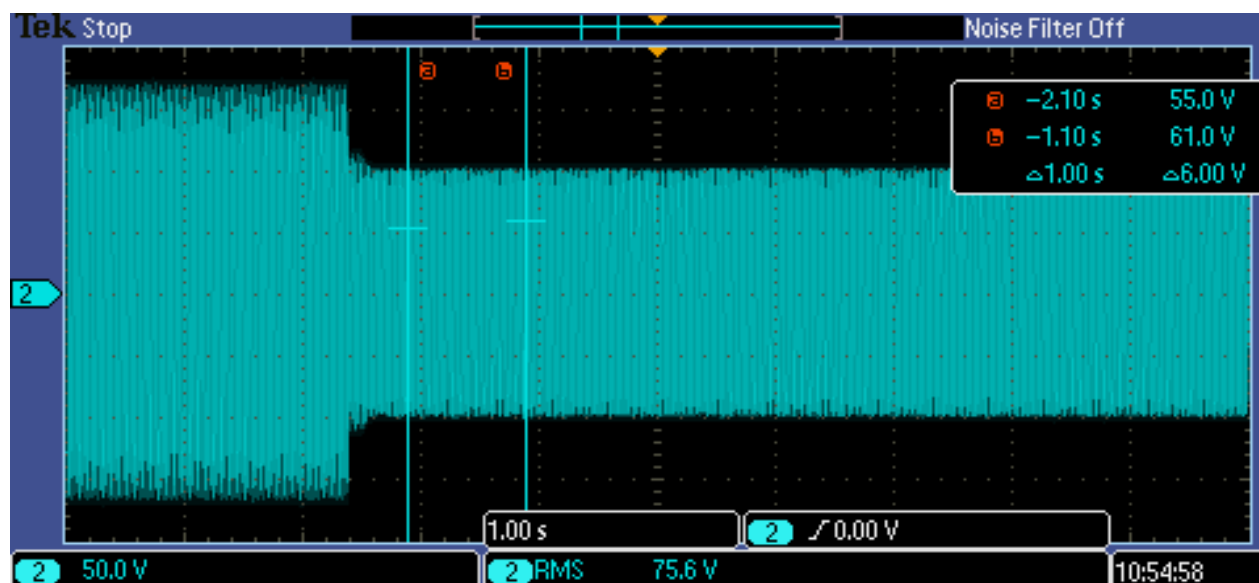
First the LED board is disconnected from the signal power supply. Then the LED signal modules are operated from a 120V AC voltage supply. A 50k-ohm resistor is wired in series in the hot line between the LED signal module and the AC power supply. A single-pole-single-throw switch is wired in parallel across the 50k-ohm resistor. A 100 k-ohm shunt resistor is wired between the hot line connection and the neutral line connection on the LED signal module. The single-pole-single-throw switch is opened and the voltage across the 100 k-ohm shunt resistor is measured from 500mS through 1500mS, after energizing the circuit with the open switch. The test was repeated 10 times.

Results

12" Green Omni Arrow	
sample	Vrms
CRT1610241001-003-001	75.9
CRT1610241001-003-002	75.6
CRT1610241001-003-003	75.7

In all samples tested the voltage across the 100KΩ resistor was greater than 70 Vac RMS.

Sample Screen Shot



Measured Voltage:	120	Vac
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Complies:	<input checked="" type="checkbox"/> YES	<input type="checkbox"/> NO
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Tested By:	John Robins	Signature or initials:	<i>JR</i>	Comp. Date	1/27/17
Reviewed By:	cwm	Signature or initials:	<i>cwm</i>		
Test Equipment Used:	9,13,14				
Amb (°f):	72	RH%	28		

Equipment list				
#	Intertek ID No.	Description	Manufacturer	Calibration Due
1	M207	multimeter	fluke	17-Aug-2017
2	H204	chamber	thermotron	10-Nov-2017
3	T1486	Digit Hygro-Thermometer	Extech	16-Mar-2017
4	V272	Signal Conditioner	Unholtz-Dickie	27-Jun-2017
5	V393	Vibration Controler	Unholtz-Dickie	15-Jul-2017
6	V328	Accelerometer	PCB Piezotronics	02-Dec-2016
7	V334	Accelerometer	PCB Piezotronics	18-Feb-2017
8	G032S	Power Analyzer	Yokogawa	09-May-2017
9	T835	Temp/Humidity	Supco	10-Jun-2017
10	O757	Spectra Scan	Photo Research	23-Mar-2017
11	R153	Distance Meter	Leica	7-Dec-2016
12	O719	flexOptometer	UDT	03-Dec-2016
13	V244	High Voltage Probe	Tektronix	03-Nov-2017
14	E470	Oscilloscope	Tektronix	08-Jul-2017
15	O109	Goniometer	Optroniks	03-Oct-2017
16	O114	5M Photometer	Optroniks	24-Oct-2017
17	T1555	Hygro-Thermometer	Extech	03-May-2017
18	M135	Multimeter	Fluke	04-Apr-2017
19	S159	Push-Pull Scale	Controls International	07-Jan-2017
20	N1153	Rain Gauge	Cole-Parmer	06-Jan-2019
21	N1419	Stopwatch	Control Co	16-Aug-2017
22	T804	Thermometer	Fluke	16-May-2017
23	Y205	Anemometer	Omega	23-May-2017
Note: For measurement uncertainty, refer to the calibration certificates for all the test equipment located in the equipment files				



Issue Date: February 27, 2017
Project No. G102472631
Quote No.: Qu-00673375

Contact: Hamid Kashani
Email: hamid@leotek.com
Phone No. 408-380-1788

Report No. 102472631CRT-001G

Leotek Electronics USA LLC

1955 Lundy Ave
San Jose, CA 95131

Standards

Performance Specification of the Institute of Transportation Engineers, Vehicle Traffic Control Signal Heads: Light Emitting Diode (LED) Circular Signal Supplement, dated June 27, 2005.

Standard Specifications Caltrans dated 2010. Section 86-4.01D(2)(a)

Test Purpose	ITE Testing of Models; TSL-12G-LX-IL6-A1-P2 & TSL-12G-LX-IL6-A1-P2-CLR
Test Dates	November 1, 2016 through February 27, 2017

John C. Robins
Engineer
Lighting

Jeremy N. Downs, P.E.
Staff Engineer
Lighting

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Test Plan and Datasheets			
Client	Leotek Electronics USA LLC	Engineer	John C. Robins
Report #	102472631CRT-001G	Reviewer	Christopher W. Metcalf
Product	12" Green Ball Tinted & Clear	Model(s)	TSL-12G-LX-IL6-A1-P2 & P2-CLR
Standard	ITE Circular Signal Supplement, dated June 27, 2005.		

Spec	Test name	Clause	Pass Fail NA
ITE	Conditioning	6.4.2	Pass
ITE	Mechanical Vibration	6.4.3.1	Pass
ITE	Temperature Cycling	6.4.3.2	Pass
ITE	Moisture Resistance	6.4.3.3	Pass
ITE	Luminous Intensity	6.4.4.1, 2,3,4	Pass
ITE	Luminance Uniformity	6.4.4.5	Pass
ITE	Chromaticity	6.4.4.6	Pass
ITE	Color Uniformity	6.4.4.7	Pass
ITE	Lens Abrasion Resistance	6.4.5.2	Pass
ITE	Current Consumption	6.4.6.1	Pass
ITE	Low Voltage Turn Off	6.4.6.2	Pass
ITE	Turn-On/Turn-Off Times	6.4.6.3	Pass
ITE	Transient Voltage Immunity	6.4.6.4	Pass
ITE	Electronic Noise	6.4.6.5	Pass
ITE	Power Factor & Total Harmonic Distortion	6.4.6.6, 7	Pass
ITE	Load Switch Compatibility	6.4.7.1	Pass
ITE	Off State Voltage Decay	6.4.7.2	Pass
ITE	Failed State Impedance	6.4.8	Pass

Sample Information				
Date Rec.	Package ID	Description	Condition	Model No.
10/24/2016	CRT1610241001-006	12" green tinted ball	production	TSL-12G-LX-IL6-A1-P2
10/24/2016	CRT1610241001-008	12" green tinted ball	production	TSL-12G-LX-IL6-A1-P2
11/7/2016	CRT1611071057-002	12" green ball clear	production	TSL-12G-LX-IL6-A1-P2-CLR
Further Sample Description				

Intertek Sample Number	Description	Model Number	Serial Number
CRT1610241001-006-001	12" green tinted ball	TSL-12G-LX-IL6-A1-P2	16917513
CRT1610241001-006-002	12" green tinted ball	TSL-12G-LX-IL6-A1-P2	16917512
CRT1610241001-006-003	12" green tinted ball	TSL-12G-LX-IL6-A1-P2	16917511
CRT1610241001-006-004	12" green tinted ball	TSL-12G-LX-IL6-A1-P2	16917510
CRT1610241001-006-005	12" green tinted ball	TSL-12G-LX-IL6-A1-P2	16917509
CRT1610241001-008-001	12" green tinted ball	TSL-12G-LX-IL6-A1-P2	16917514
CRT1611071057-002-001	12" green ball clear	TSL-12G-LX-IL6-A1-P2-CLR	T16B009
CRT1611071057-002-002	12" green ball clear	TSL-12G-LX-IL6-A1-P2-CLR	T16B008
CRT1611071057-002-003	12" green ball clear	TSL-12G-LX-IL6-A1-P2-CLR	T16B007

General Requirements

Intertek Sample Number	ETL Cert. Number	Label Identification	Lens Orientation	Color Coded Wires
CRT1610241001-006-001	7080583	Pass	Pass	Brown/White
CRT1610241001-006-002	7080582	Pass	Pass	Brown/White
CRT1610241001-006-003	7080581	Pass	Pass	Brown/White
CRT1610241001-006-004	7080580	Pass	Pass	Brown/White
CRT1610241001-006-005	7080579	Pass	Pass	Brown/White
CRT1610241001-008-001	7080584	Pass	Pass	Brown/White
CRT1611071057-002-001	6596142	Pass	Pass	Brown/White
CRT1611071057-002-002	6596138	Pass	Pass	Brown/White
CRT1611071057-002-003	6596143	Pass	Pass	Brown/White

General Requirements

Intertek Sample Number	600V / 20 AWG Min.	Wire Length \geq 39"	Service Rating +105°C
CRT1610241001-006-001	600V/18AWG	Pass	Pass
CRT1610241001-006-002	600V/18AWG	Pass	Pass
CRT1610241001-006-003	600V/18AWG	Pass	Pass
CRT1610241001-006-004	600V/18AWG	Pass	Pass
CRT1610241001-006-005	600V/18AWG	Pass	Pass
CRT1610241001-008-001	600V/18AWG	Pass	Pass
CRT1611071057-002-001	600V/18AWG	Pass	Pass
CRT1611071057-002-002	600V/18AWG	Pass	Pass
CRT1611071057-002-003	600V/18AWG	Pass	Pass

Picture(s)

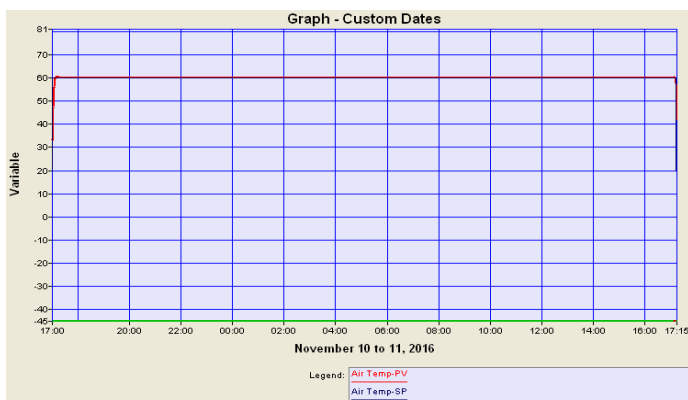
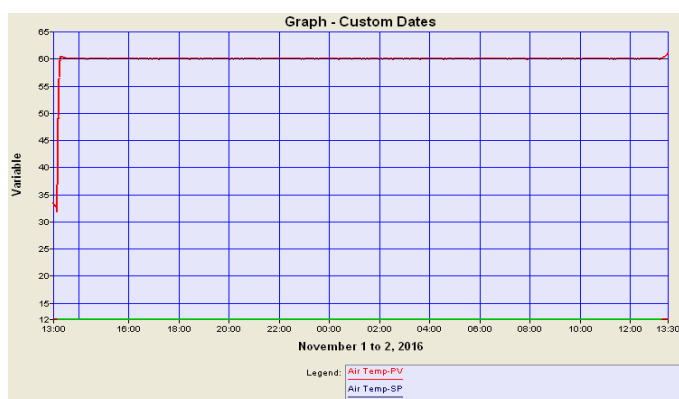


Conditioning 6.4.2

The submitted LED signal modules were subjected to conditioning prior to the environmental tests. The samples were energized for a minimum of 24 hours, at 100% duty cycle in an ambient temperature of +60°C (+140°F). At the conclusion of the test, the modules shall be visually inspected for damage and checked for proper operation.

Results

Intertek Sample Number	Description	Visual Inspection		Operational Check	
		Pre	Post	Pre	Post
CRT1610241001-006-001	12" green tinted ball	Pass	Pass	Pass	Pass
CRT1610241001-006-002	12" green tinted ball	Pass	Pass	Pass	Pass
CRT1610241001-006-003	12" green tinted ball	Pass	Pass	Pass	Pass
CRT1610241001-006-004	12" green tinted ball	Pass	Pass	Pass	Pass
CRT1610241001-006-005	12" green tinted ball	Pass	Pass	Pass	Pass
CRT1610241001-008-001	12" green tinted ball	Pass	Pass	Pass	Pass
CRT1611071057-002-001	12" green ball clear	Pass	Pass	Pass	Pass
CRT1611071057-002-002	12" green ball clear	Pass	Pass	Pass	Pass
CRT1611071057-002-003	12" green ball clear	Pass	Pass	Pass	Pass



Measured Voltage: 119.3 Vac

Complies: ☒ YES ☐ NO

Tested By:	John Robins	Signature or initials:	<i>JR</i>	Comp. Date	11/2/16
Reviewed By:	cwm	Signature or initials:	<i>cwm</i>	Comp. Date	11/11/16
Test Equipment Used:	1,2				
Amb (°C):	na	RH%	na		

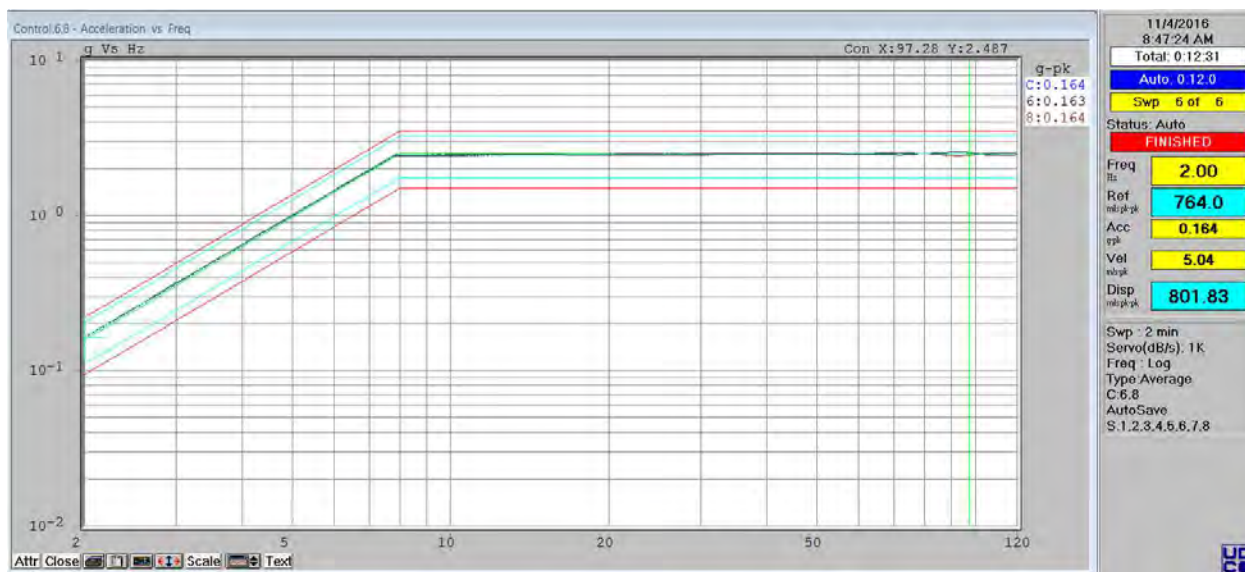
Mechanical Vibration 6.4.3.1

The submitted LED signal modules were securely mounted in traffic signal housings and vibrated along each axes for three 4 minute sweep cycles at a displacement of 0.764" from 2 to 8 Hz and 2.5 Gs from 8 to 120 Hz. Testing was conducted in accordance with MIL-STD-883, method 2007. At the conclusion of the test, the modules shall be visually inspected for damage and checked for proper operation.

Results

Intertek Sample Number	Description	x-axis lateral	y-axis horizontal	z-axis vertical	Visual Inspection	Operational Check
CRT1610241001-006-001	12" green tinted ball	X	X	X	Pass	Pass
CRT1610241001-006-002	12" green tinted ball	X	X	X	Pass	Pass
CRT1610241001-006-003	12" green tinted ball	X	X	X	Pass	Pass
CRT1610241001-006-004	12" green tinted ball	X	X	X	Pass	Pass
CRT1610241001-006-005	12" green tinted ball	X	X	X	Pass	Pass
CRT1610241001-008-001	12" green tinted ball	X	X	X	Pass	Pass

Sample Vibration Plot



Complies: ☒ YES ☐ NO

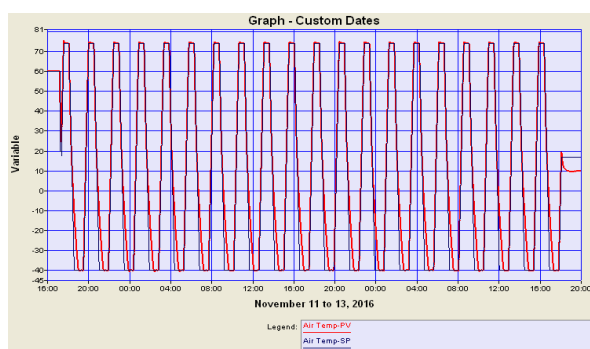
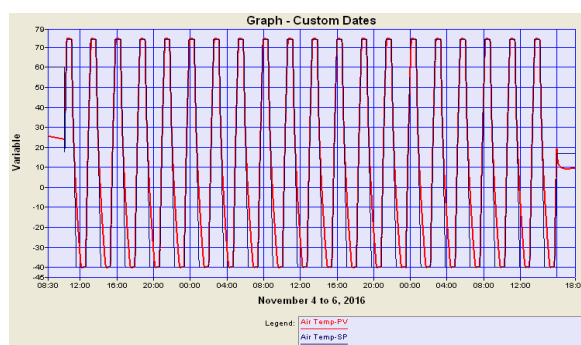
Tested By:	Gordon West	Signature or initials:	<i>Gordon West</i>	Comp. Date	11/4/16
Reviewed By:	cwm	Signature or initials:	<i>cwm</i>		
Test Equipment Used:	3,4,5,6,7				
Amb (°C):	22.8	RH%	33		

Temperature Cycling 6.4.3.2

The submitted tinted and clear LED signal modules were subjected to temperature cycling according to MIL-STD-883, Method 1010. Twenty cycles were performed with a 30 minute transfer time between temperature extremes and a 30 minute dwell time at the extremes. The temperature cycled between -40°C and +74°C. The samples were non-operating. At the conclusion of the test, the module shall be free of damage and moisture and be fully operational.

Results

Intertek Sample Number	Description	Visual Inspection	Operational Check
CRT1610241001-006-001	12" green tinted ball	Pass	Pass
CRT1610241001-006-002	12" green tinted ball	Pass	Pass
CRT1610241001-006-003	12" green tinted ball	Pass	Pass
CRT1610241001-006-004	12" green tinted ball	Pass	Pass
CRT1610241001-006-005	12" green tinted ball	Pass	Pass
CRT1610241001-008-001	12" green tinted ball	Pass	Pass
CRT1611071057-002-001	12" green ball clear	Pass	Pass
CRT1611071057-002-002	12" green ball clear	Pass	Pass
CRT1611071057-002-003	12" green ball clear	Pass	Pass



Complies: ☒ YES ☐ NO

Tested By:	John Robins	Signature or initials:	<i>JR</i>	Comp. Date	11/6/16
Reviewed By:	cwm	Signature or initials:	<i>cwm</i>	Comp. Date	11/13/16
Test Equipment Used:	1				
Amb (°C):	na	RH%	na		

Moisture Resistance 6.4.3.3

The submitted tinted and clear LED signal modules were subjected to the rain and blowing rain test per MIL-STD-810F, Test Method 506.4, Procedure I. The test was performed on standalone modules without a protective housing. The rainfall rate was 1.7 mm/min (4in/hr) and the droplet size shall predominantly be between 0.5mm and 4.5mm (0.02 to 0.18 in). The samples were oriented such that the lens is directed towards the wind source when at a zero rotation angle. The samples were rotated at a rate of 4 degrees per minute along the vertical axis, from an orientation of -60 to +60 degrees during the test. The duration of the test is 30 minutes, and the samples were energized throughout the test. The water temperature was $25^{\circ} \pm 5^{\circ}\text{C}$ ($77^{\circ} \pm 9^{\circ}\text{F}$) and the wind velocity was 80 km/hr (50 mph). At the conclusion of the test, the module shall be free of damage and moisture and be fully operational.

Results

Intertek Sample Number	Description	Visual Inspection	Operational Check
CRT1610241001-006-001	12" green tinted ball	Pass	Pass
CRT1610241001-006-002	12" green tinted ball	Pass	Pass
CRT1610241001-006-003	12" green tinted ball	Pass	Pass
CRT1610241001-006-004	12" green tinted ball	Pass	Pass
CRT1610241001-006-005	12" green tinted ball	Pass	Pass
CRT1610241001-008-001	12" green tinted ball	Pass	Pass
CRT1611071057-002-001	12" green ball clear	Pass	Pass
CRT1611071057-002-002	12" green ball clear	Pass	Pass
CRT1611071057-002-003	12" green ball clear	Pass	Pass

Requirement: Signal Still Operational and No Moisture In The Housing

Intertek Sample Number	Sample Temp. at start ($^{\circ}\text{C}$)	Water Temperature $25\text{C} \pm 5\text{C}$			
		Start	10 minutes in.	20 minutes in.	30 minutes in.
CRT1610241001-006-001	40	25.0	24.9	24.1	24.6
CRT1610241001-006-002	40				
CRT1610241001-006-003	40				
CRT1610241001-006-004	40	26.6	25.3	24.9	24.7
CRT1610241001-006-005	40				
CRT1610241001-008-001	40				
CRT1611071057-002-001	40	26.3	25.5	25.8	26.2
CRT1611071057-002-002	40				
CRT1611071057-002-003	40				
CRT1611071057-002-001	40	30.0	28.8	25.3	23.2
CRT1611071057-002-002	40				
CRT1611071057-002-003	40				
CRT1611071057-002-001	40	26.8	25.8	25.0	24.5
CRT1611071057-002-002	40				
CRT1611071057-002-003	40				

* Water temperature is $^{\circ}\text{C}$

Recorded rainfall rate:	4.3	in/hr
Recorded wind velocity:	48-52	mph

Complies: ☒ YES ☐ NO

Tested By:	Kurt Dobler	Signature or initials:	kfd	Comp. Date:	2/24/17
Reviewed By:	JND	Signature or initials:	JND		
Test Equipment Used:	21,22,23,24				
Amb ($^{\circ}\text{C}$):	NA	RH%	NA		

Luminous Intensity 6.4.4.1 through 6.4.4.4

The intensity distribution tests on the submitted LED traffic signal modules were performed with the Intertek 25 meter Goniophotometer. The goniophotometer was in accordance with the goniometer described in Section 11.02 (Test Apparatus) of the Institute of Transportation Engineers' Vehicle Traffic Control Signal Heads Standard Test Method. The calibration of the goniophotometer is traceable to the National Institute of Standards and Technology. The LED modules were operated at 120 volts AC. The alignment of the LED module was performed in accordance with Section 11.03 (Alignment of Optical Unit for Test) of the Institute of Transportation Engineers' Vehicle Traffic Control Signal Heads Standard Test Method. The submitted LED signal modules were tested for maintained minimum luminous intensity at each of 78 points indicated in Table 1, of the referenced specification. These measurements were recorded at an ambient temperature of 25°C. The green LED signal modules were energized at nominal operating voltage, at a 100% duty cycle for 60 minutes.

A relative luminous intensity measurement is taken in a region from 0 to 7.5° down, and from 7.5° left to 7.5° right. The measurement is taken at 80 Vac, 120 Vac and 135 Vac. When the 80 Vac and 135 Vac factors are applied to the photometric data the units shall still meet the photometric requirements of each model.

A diminution factor was measured by using the submitted samples. The modules were mounted in a dual compartment temperature chamber with the lensed portion in one compartment and all portions behind the lens within the other compartment. At room ambient temperature (both inside and outside the chamber) and in calm air outside the chamber, the modules were energized per the conditions described above and a single on-axis reading (IA) taken and recorded. With the modules off, the chamber was heated to 74°C behind the lens and 49°C in front of the lens, and allowed to stabilize. Following stabilization, the modules were energized per the above cycle and the single on-axis reading (IH) taken and recorded. A diminution factor was calculated (IH/IA). The readings recorded initially were factored by the diminution factor.

Luminous Intensity 6.4.4.1 through 6.4.4.4

Sample	CRT1610241001-006-004				Target Input voltage		Measured Input Voltage			H, V Lum. Intensity		Vac Variation Factor		MMLI Factor
Module	12" Ball				80Vac		80.3		Vac		651.2	Candela	0.996	1.008
Color:	Green				120Vac		120.1		Vac		653.5	Candela	1.000	
Lens	Tinted				135Vac		135.0		Vac		652.8	Candela	0.999	
Photometric Test Distance: 25 meters														
Max	1425	25°C				25°C		25°C		74°C/49°C		74°C/49°C		74°C/49°C
Vertical	Horizontal	Rated 80Vac		Measured 120Vac		Rated 135Vac		Rated 80Vac		Measured 120Vac		Rated 135Vac		Table 1
Angle	Angle	Candela	Candela	Candela	Candela	Candela	Candela	Candela	Candela	Candela	Candela	Candela	Candela	Minimum
Up/Down	Left/Right	Left	Right	Left	Right	Left	Right	Left	Right	Left	Right	Left	Right	Candela
12.5U	2.5	89	90	89	90	89	90	90	90	90	91	90	91	48
12.5U	7.5	69	71	69	71	69	71	69	71	70	72	69	72	38
7.5U	2.5	142	144	143	145	143	145	143	145	144	146	144	146	90
7.5U	7.5	110	116	110	116	110	116	110	117	111	117	111	117	71
7.5U	12.5	78	85	78	86	78	86	78	86	79	86	78	86	52
2.5U	2.5	356	365	358	366	357	366	359	368	360	369	360	369	195
2.5U	7.5	264	279	265	280	265	279	266	281	267	282	267	282	162
2.5U	12.5	177	192	178	192	177	192	178	193	179	194	179	194	109
2.5U	17.5	104	121	105	121	104	121	105	122	105	122	105	122	62
2.5U	22.5	66	81	66	81	66	81	66	82	67	82	66	82	33
2.5D	2.5	938	945	941	949	940	948	945	953	949	956	948	955	466
2.5D	7.5	692	688	695	690	694	689	697	693	700	695	699	695	380
2.5D	12.5	462	456	463	458	463	457	465	460	467	461	466	461	261
2.5D	17.5	259	268	260	269	260	268	261	270	262	271	262	270	152
2.5D	22.5	162	173	162	173	162	173	163	174	163	175	163	174	81
2.5D	27.5	102	98	103	98	102	98	103	99	103	99	103	99	43
7.5D	2.5	778	779	780	782	779	781	784	785	786	788	786	787	366
7.5D	7.5	579	558	581	560	580	560	583	563	585	565	585	564	304
7.5D	12.5	382	364	383	366	382	365	385	367	386	368	385	368	204
7.5D	17.5	213	208	214	209	214	208	215	209	216	210	215	210	119
7.5D	22.5	126	133	127	134	126	133	127	134	128	135	127	134	62
7.5D	27.5	80	79	80	79	80	79	80	79	81	79	81	79	33
12.5D	2.5	300	301	301	302	300	302	302	304	303	305	303	304	143
12.5D	7.5	223	225	224	226	224	225	225	227	226	227	225	227	114
12.5D	12.5	151	156	152	157	152	157	152	158	153	158	153	158	81
12.5D	17.5	88	97	89	98	88	98	89	98	89	99	89	98	48
12.5D	22.5	57	65	57	65	57	65	57	65	58	65	57	65	24
12.5D	27.5	40	43	40	43	40	43	41	43	41	43	41	43	14
17.5D	2.5	184	187	184	188	184	188	185	189	186	189	186	189	67
17.5D	7.5	138	142	139	143	138	143	139	144	140	144	140	144	52
17.5D	12.5	94	101	94	101	94	101	94	102	95	102	95	102	38
17.5D	17.5	59	66	59	66	59	66	59	66	59	66	59	66	19
17.5D	22.5	41	47	42	47	42	47	42	48	42	48	42	48	10
22.5D	2.5	126	128	126	129	126	129	127	129	127	130	127	130	48
22.5D	7.5	98	100	99	100	98	100	99	101	99	101	99	101	38
22.5D	12.5	70	73	71	73	70	73	71	73	71	73	71	73	29
22.5D	17.5	47	50	47	50	47	50	47	51	47	51	47	51	14
27.5D	2.5	85	86	85	86	85	86	86	87	86	87	86	87	33
27.5D	7.5	68	68	68	68	68	68	69	68	69	69	69	69	24

Luminous Intensity 6.4.4.1 through 6.4.4.4

Sample:	CRT1610241001-006-005			Target Input voltage		Measured Input Voltage				H, V Lum. Intensity		Vac Variation Factor		MMU Factor	
Module	12" Ball			80Vac		80.3		Vac		641.5		Candela		0.993	0.997
Color:	Green			120Vac		120.4		Vac		646.0		Candela		1.000	
Lens	Tinted			135Vac		135.0		Vac		642.2		Candela		0.994	
Photometric Test Distance: 25 meters															
Max	1425	25°C		25°C		25°C		74°C/49°C		74°C/49°C		74°C/49°C			
Vertical	Horizontal	Rated 80Vac		Measured 120Vac		Rated 135Vac		Rated 80Vac		Measured 120Vac		Rated 135Vac		Table 1	
Angle	Angle	Candela	Candela	Candela	Candela	Candela	Candela	Candela	Candela	Candela	Candela	Candela	Candela	Minimum	
Up/Down	Left/Right	Left	Right	Left	Right	Left	Right	Left	Right	Left	Right	Left	Right	Candela	
12.5U	2.5	88	89	89	89	89	89	88	88	89	89	88	88	48	
12.5U	7.5	68	70	68	71	68	70	67	70	68	71	67	70	38	
7.5U	2.5	141	144	142	145	141	145	140	144	141	145	140	144	90	
7.5U	7.5	107	116	108	117	107	117	107	116	107	117	107	116	71	
7.5U	12.5	76	87	76	87	76	87	75	86	76	87	75	86	52	
2.5U	2.5	345	359	348	361	346	359	344	358	347	360	345	358	195	
2.5U	7.5	252	277	254	279	253	278	252	277	253	278	252	277	162	
2.5U	12.5	167	194	168	195	167	194	166	193	167	194	166	193	109	
2.5U	17.5	96	122	97	123	96	123	96	122	96	123	96	122	62	
2.5U	22.5	60	82	60	83	60	82	60	82	60	83	60	82	33	
2.5D	2.5	906	927	913	934	907	928	903	924	909	930	904	925	466	
2.5D	7.5	655	691	659	696	655	692	652	688	657	693	653	689	380	
2.5D	12.5	433	463	436	466	434	463	432	461	435	465	432	462	261	
2.5D	17.5	242	266	244	268	243	267	242	265	243	267	242	266	152	
2.5D	22.5	149	172	150	174	149	172	148	172	149	173	149	172	81	
2.5D	27.5	94	98	94	99	94	98	93	98	94	98	93	98	43	
7.5D	2.5	768	765	774	771	769	766	766	763	771	768	766	763	366	
7.5D	7.5	574	541	578	544	574	541	572	539	576	542	572	539	304	
7.5D	12.5	378	355	381	358	379	355	377	354	380	356	378	354	204	
7.5D	17.5	212	199	214	200	212	199	211	198	213	200	212	198	119	
7.5D	22.5	129	126	130	127	129	126	129	126	130	127	129	126	62	
7.5D	27.5	82	75	82	75	82	75	81	74	82	75	81	75	33	
12.5D	2.5	288	292	291	294	289	293	287	291	290	293	288	292	143	
12.5D	7.5	216	219	217	221	216	220	215	219	217	220	215	219	114	
12.5D	12.5	146	153	147	154	146	153	145	152	146	153	146	152	81	
12.5D	17.5	85	94	85	94	85	94	84	93	85	94	84	93	48	
12.5D	22.5	55	62	55	63	55	62	55	62	55	63	55	62	24	
12.5D	27.5	39	42	39	42	39	42	39	42	39	42	39	42	14	
17.5D	2.5	175	183	177	184	176	183	175	182	176	183	175	182	67	
17.5D	7.5	131	139	132	140	131	139	131	138	132	139	131	139	52	
17.5D	12.5	89	99	89	100	89	99	88	99	89	99	88	99	38	
17.5D	17.5	56	64	57	65	56	64	56	64	57	64	56	64	19	
17.5D	22.5	39	46	40	47	39	46	39	46	39	47	39	46	10	
22.5D	2.5	121	127	122	128	121	127	121	126	122	127	121	127	48	
22.5D	7.5	93	99	94	100	94	99	93	99	94	99	93	99	38	
22.5D	12.5	66	71	66	72	66	72	66	71	66	72	66	71	29	
22.5D	17.5	44	49	44	50	44	49	44	49	44	50	44	49	14	
27.5D	2.5	82	85	82	86	82	85	82	85	82	86	82	85	33	
27.5D	7.5	65	67	65	67	65	67	65	66	65	67	65	67	24	

Luminous Intensity 6.4.4.1 through 6.4.4.4

Sample:	CRT1610241001-008-001			Target Input voltage		Measured Input Voltage				H, V Lum. Intensity		Vac Variation Factor		MMU Factor
Module	12" Ball			80Vac		80.2		Vac		704.8	Candela	0.998		1.006
Color:	Green			120Vac		120.1		Vac		706.5	Candela	1.000		
Lens	Tinted			135Vac		135.5		Vac		706.9	Candela	1.001		
Photometric Test Distance: 25 meters														
Max	1425	25°C		25°C		25°C		74°C/49°C		74°C/49°C		74°C/49°C		
Vertical	Horizontal	Rated 80Vac		Measured 120Vac		Rated 135Vac		Rated 80Vac		Measured 120Vac		Rated 135Vac		Table 1
Angle	Angle	Candela	Candela	Candela	Candela	Candela	Candela	Candela	Candela	Candela	Candela	Candela	Candela	Minimum
Up/Down	Left/Right	Left	Right	Left	Right	Left	Right	Left	Right	Left	Right	Left	Right	Candela
12.5U	2.5	90	94	90	94	90	94	91	94	91	95	91	95	48
12.5U	7.5	69	74	69	74	70	74	70	75	70	75	70	75	38
7.5U	2.5	152	156	152	156	152	156	153	157	153	157	153	157	90
7.5U	7.5	118	123	118	124	118	124	119	124	119	124	119	124	71
7.5U	12.5	83	89	83	90	83	90	84	90	84	90	84	90	52
2.5U	2.5	391	391	392	392	392	392	393	393	394	394	395	394	195
2.5U	7.5	295	292	296	293	296	293	297	294	298	295	298	295	162
2.5U	12.5	199	198	199	198	200	198	200	199	201	199	201	199	109
2.5U	17.5	115	119	115	119	115	119	116	119	116	120	116	120	62
2.5U	22.5	73	76	74	76	74	76	74	77	74	77	74	77	33
2.5D	2.5	931	939	933	941	934	942	937	945	939	947	940	947	466
2.5D	7.5	687	677	689	678	689	679	691	681	693	683	693	683	380
2.5D	12.5	461	453	462	454	463	454	464	456	465	457	465	457	261
2.5D	17.5	257	258	257	259	257	259	258	260	259	261	259	261	152
2.5D	22.5	161	162	161	162	161	162	162	163	162	163	162	163	81
2.5D	27.5	104	90	104	90	104	90	104	90	105	91	105	91	43
7.5D	2.5	729	733	731	735	732	735	734	738	736	739	736	740	366
7.5D	7.5	526	541	527	542	528	543	529	544	531	546	531	546	304
7.5D	12.5	342	364	343	365	343	365	345	366	345	367	346	367	204
7.5D	17.5	185	211	185	211	186	212	186	212	187	213	187	213	119
7.5D	22.5	106	136	106	137	106	137	106	137	106	137	107	137	62
7.5D	27.5	68	80	68	80	68	80	68	80	68	80	68	80	33
12.5D	2.5	298	299	299	300	299	300	300	301	300	301	301	302	143
12.5D	7.5	218	226	219	226	219	227	220	227	220	228	220	228	114
12.5D	12.5	146	158	146	158	146	158	147	158	147	159	147	159	81
12.5D	17.5	82	99	82	100	82	100	83	100	83	100	83	100	48
12.5D	22.5	53	66	53	67	53	67	53	67	53	67	53	67	24
12.5D	27.5	37	43	37	44	37	44	37	44	37	44	37	44	14
17.5D	2.5	186	185	187	186	187	186	187	186	188	187	188	187	67
17.5D	7.5	139	142	139	142	139	142	140	143	140	143	140	143	52
17.5D	12.5	95	100	95	100	95	100	95	100	96	101	96	101	38
17.5D	17.5	59	65	59	66	59	66	59	66	59	66	59	66	19
17.5D	22.5	40	47	40	47	40	47	40	47	40	47	40	47	10
22.5D	2.5	127	124	127	124	127	124	128	125	128	125	128	125	48
22.5D	7.5	98	97	98	98	99	98	99	98	99	98	99	98	38
22.5D	12.5	70	70	71	70	71	70	71	71	71	71	71	71	29
22.5D	17.5	46	49	46	50	46	50	47	50	47	50	47	50	14
27.5D	2.5	87	84	88	84	88	84	88	84	88	85	88	85	33
27.5D	7.5	69	66	69	66	69	66	69	66	69	66	69	67	24

Luminous Intensity 6.4.4.1 through 6.4.4.4

Sample:	CRT1611071057-002-001			Target Input voltage		Measured Input Voltage				H, V Lum. Intensity		Vac Variation Factor		MMU Factor
Module	12" Ball			80Vac		80.2		Vac		788.1	Candela	0.996		1.086
Color:	Green			120Vac		120.3		Vac		791.3	Candela	1.000		
Lens	Clear			135Vac		135.2		Vac		791.2	Candela	1.000		
Photometric Test Distance: 25 meters														
Max	1425	25°C		25°C		25°C		74°C/49°C		74°C/49°C		74°C/49°C		
Vertical	Horizontal	Rated 80Vac		Measured 120Vac		Rated 135Vac		Rated 80Vac		Measured 120Vac		Rated 135Vac		Table 1
Angle	Angle	Candela	Candela	Candela	Candela	Candela	Candela	Candela	Candela	Candela	Candela	Candela	Candela	Minimum
Up/Down	Left/Right	Left	Right	Left	Right	Left	Right	Left	Right	Left	Right	Left	Right	Candela
12.5U	2.5	103	103	104	103	104	103	112	111	113	112	113	112	48
12.5U	7.5	78	82	79	82	79	82	85	89	86	89	86	89	38
7.5U	2.5	172	178	173	179	173	179	187	194	187	194	187	194	90
7.5U	7.5	129	144	129	145	129	145	140	157	140	157	140	157	71
7.5U	12.5	88	107	88	107	88	107	96	116	96	117	96	117	52
2.5U	2.5	427	450	428	452	428	452	463	489	465	491	465	491	195
2.5U	7.5	306	360	308	361	307	361	333	391	334	392	334	392	162
2.5U	12.5	196	258	197	259	197	259	213	280	214	281	214	281	109
2.5U	17.5	109	164	110	164	110	164	119	178	119	178	119	178	62
2.5U	22.5	66	110	66	111	66	110	71	120	71	120	71	120	33
2.5D	2.5	1059	1079	1063	1083	1063	1083	1150	1172	1155	1176	1154	1176	466
2.5D	7.5	763	804	767	808	767	808	829	874	833	877	833	877	380
2.5D	12.5	497	551	499	554	499	553	540	599	542	601	542	601	261
2.5D	17.5	266	323	267	325	267	324	289	351	290	352	290	352	152
2.5D	22.5	159	206	160	207	160	207	173	224	173	225	173	225	81
2.5D	27.5	99	115	99	115	99	115	107	125	108	125	108	125	43
7.5D	2.5	864	854	868	858	867	857	938	928	942	932	942	931	366
7.5D	7.5	667	597	669	599	669	599	724	648	727	651	727	651	304
7.5D	12.5	447	394	449	396	449	395	485	428	487	430	487	430	204
7.5D	17.5	253	220	254	221	254	221	274	239	275	240	275	240	119
7.5D	22.5	153	133	154	134	154	134	166	145	167	145	167	145	62
7.5D	27.5	99	77	99	77	99	77	107	83	108	84	108	84	33
12.5D	2.5	346	353	348	355	348	355	376	384	378	385	378	385	143
12.5D	7.5	263	264	264	265	264	265	285	286	286	288	286	287	114
12.5D	12.5	179	182	180	183	180	182	194	197	195	198	195	198	81
12.5D	17.5	104	109	104	110	104	110	113	119	113	119	113	119	48
12.5D	22.5	66	70	67	70	67	70	72	76	72	76	72	76	24
12.5D	27.5	48	46	48	46	48	46	52	50	52	50	52	50	14
17.5D	2.5	203	218	204	219	204	218	221	236	222	237	222	237	67
17.5D	7.5	153	168	153	169	153	169	166	182	166	183	166	183	52
17.5D	12.5	102	117	103	118	103	118	111	128	112	128	112	128	38
17.5D	17.5	65	75	65	75	65	75	71	81	71	81	71	81	19
17.5D	22.5	46	52	46	52	46	52	50	57	50	57	50	57	10
22.5D	2.5	136	148	137	148	137	148	148	160	149	161	149	161	48
22.5D	7.5	106	116	107	116	107	116	115	126	116	126	116	126	38
22.5D	12.5	74	83	74	84	74	84	80	91	81	91	81	91	29
22.5D	17.5	50	56	50	56	50	56	54	61	54	61	54	61	14
27.5D	2.5	93	99	93	99	93	99	101	107	101	108	101	108	33
27.5D	7.5	73	78	74	79	74	79	80	85	80	85	80	85	24


Luminous Intensity 6.4.4.1 through 6.4.4.4

Sample:	CRT1611071057-002-002			Target Input voltage		Measured Input Voltage		H, V Lum. Intensity		Vac Variation Factor		MMU Factor	
Module	12" Ball			80Vac		80.0		Vac		800.0		Candela	
Color:	Green			120Vac		120.3		Vac		802.6		Candela	
Lens	Clear			135Vac		135.3		Vac		802.4		Candela	
Photometric Test Distance: 25 meters													
Max	1425	25°C		25°C		25°C		74°C/49°C		74°C/49°C		74°C/49°C	
Vertical	Horizontal	Rated 80Vac		Measured 120Vac		Rated 135Vac		Rated 80Vac		Measured 120Vac		Rated 135Vac	
Angle	Angle	Candela	Candela	Candela	Candela	Candela	Candela	Candela	Candela	Candela	Candela	Candela	Candela
Up/Down	Left/Right	Left	Right	Left	Right	Left	Right	Left	Right	Left	Right	Left	Right
12.5U	2.5	105	103	106	103	106	103	110	107	110	107	110	107
12.5U	7.5	80	81	80	82	80	82	83	85	84	85	83	85
7.5U	2.5	169	174	170	174	169	174	176	181	177	181	177	181
7.5U	7.5	126	142	127	142	126	142	131	148	132	148	132	148
7.5U	12.5	87	106	87	107	87	107	91	111	91	111	91	111
2.5U	2.5	419	448	420	450	420	449	436	467	438	468	438	468
2.5U	7.5	297	360	298	361	298	361	309	375	310	376	310	376
2.5U	12.5	188	262	189	263	189	263	196	273	197	274	197	273
2.5U	17.5	104	171	105	171	105	171	109	178	109	178	109	178
2.5U	22.5	63	117	63	118	63	118	65	122	66	123	66	123
2.5D	2.5	1064	1109	1067	1113	1067	1113	1108	1156	1111	1159	1111	1159
2.5D	7.5	763	835	766	838	766	838	795	870	798	873	797	873
2.5D	12.5	496	575	497	577	497	577	516	599	518	601	518	601
2.5D	17.5	260	334	261	335	260	335	270	348	271	349	271	349
2.5D	22.5	151	213	152	214	152	213	158	222	158	222	158	222
2.5D	27.5	94	119	94	119	94	119	97	123	98	124	98	124
7.5D	2.5	868	862	870	864	870	864	904	897	907	900	906	900
7.5D	7.5	673	587	675	589	675	589	701	612	703	614	703	613
7.5D	12.5	446	385	448	386	448	386	465	401	466	402	466	402
7.5D	17.5	256	211	257	212	257	211	267	220	268	220	268	220
7.5D	22.5	159	127	160	127	160	127	166	132	167	133	167	133
7.5D	27.5	105	73	105	74	105	74	109	76	109	77	109	77
12.5D	2.5	334	345	335	346	335	346	348	360	349	361	349	361
12.5D	7.5	254	255	255	256	255	256	265	266	266	267	266	267
12.5D	12.5	172	174	173	175	173	175	179	181	180	182	180	182
12.5D	17.5	102	104	102	105	102	104	106	108	107	109	107	109
12.5D	22.5	67	68	67	68	67	68	70	71	70	71	70	71
12.5D	27.5	49	45	49	45	49	45	51	47	51	47	51	47
17.5D	2.5	197	215	198	215	198	215	206	224	206	224	206	224
17.5D	7.5	148	166	148	166	148	166	154	172	155	173	155	173
17.5D	12.5	99	118	99	118	99	118	103	123	103	123	103	123
17.5D	17.5	63	75	64	75	64	75	66	78	66	78	66	78
17.5D	22.5	45	52	45	52	45	52	47	54	47	54	47	54
22.5D	2.5	132	147	133	147	133	147	138	153	138	153	138	153
22.5D	7.5	103	116	104	117	104	117	108	121	108	121	108	121
22.5D	12.5	71	84	71	84	71	84	74	88	74	88	74	88
22.5D	17.5	49	56	49	57	49	57	51	59	51	59	51	59
27.5D	2.5	90	98	91	98	90	98	94	102	94	102	94	102
27.5D	7.5	72	79	72	79	72	79	75	82	75	82	75	82

Luminous Intensity 6.4.4.1 through 6.4.4.4

Sample:	CRT1611071057-002-003			Target Input voltage		Measured Input Voltage			H, V Lum. Intensity		Vac Variation Factor		MMU Factor				
Module	12" Ball			80Vac		80.4		Vac		790.3		Candela		0.993		1.051	
Color:	Green			120Vac		120.4		Vac		795.5		Candela		1.000			
Lens	Clear			135Vac		135.2		Vac		797.1		Candela		1.002			
Photometric Test Distance: 25 meters																	
Max	1425		25°C		25°C		25°C		74°C/49°C		74°C/49°C		74°C/49°C				
Vertical	Horizontal		Rated 80Vac		Measured 120Vac		Rated 135Vac		Rated 80Vac		Measured 120Vac		Rated 135Vac		Table 1		
Angle	Angle	Candela	Candela	Candela	Candela	Candela	Candela	Candela	Candela	Candela	Candela	Candela	Candela	Candela	Minimum		
Up/Down	Left/Right	Left	Right	Left	Right	Left	Right	Left	Right	Left	Right	Left	Right	Candela			
12.5U	2.5	106	104	106	105	106	105	111	109	112	110	112	110	48			
12.5U	7.5	81	82	82	83	82	83	85	86	86	87	86	87	38			
7.5U	2.5	172	175	173	176	173	177	181	184	182	185	182	186	90			
7.5U	7.5	131	142	131	143	132	143	137	149	138	150	138	150	71			
7.5U	12.5	91	106	91	106	91	106	95	111	96	112	96	112	52			
2.5U	2.5	431	449	434	452	435	453	453	472	456	475	457	476	195			
2.5U	7.5	313	353	315	356	316	356	329	371	331	374	332	375	162			
2.5U	12.5	203	249	204	250	205	251	213	261	215	263	215	264	109			
2.5U	17.5	115	160	116	161	116	161	121	168	122	169	122	170	62			
2.5U	22.5	70	107	70	108	71	108	73	113	74	114	74	114	33			
2.5D	2.5	1068	1079	1075	1086	1077	1088	1123	1134	1130	1142	1132	1144	466			
2.5D	7.5	776	803	781	808	782	810	815	844	821	849	822	851	380			
2.5D	12.5	510	541	514	545	515	546	537	569	540	573	541	574	261			
2.5D	17.5	279	317	281	319	281	319	293	333	295	335	295	336	152			
2.5D	22.5	166	200	167	201	168	202	175	210	176	211	176	212	81			
2.5D	27.5	103	112	104	112	104	113	109	117	109	118	110	118	43			
7.5D	2.5	880	857	885	863	887	864	925	901	931	907	933	908	366			
7.5D	7.5	675	606	680	610	681	611	710	637	714	641	716	642	304			
7.5D	12.5	450	393	453	395	454	396	473	413	476	415	477	416	204			
7.5D	17.5	256	222	258	224	259	224	269	233	271	235	272	236	119			
7.5D	22.5	155	136	156	137	156	137	163	143	164	144	164	144	62			
7.5D	27.5	99	79	100	79	100	79	104	83	105	83	105	83	33			
12.5D	2.5	353	358	355	361	356	361	371	376	373	379	374	380	143			
12.5D	7.5	269	265	271	267	271	268	283	279	285	281	285	281	114			
12.5D	12.5	184	181	185	182	186	183	193	190	195	192	195	192	81			
12.5D	17.5	107	110	108	111	108	111	113	116	114	117	114	117	48			
12.5D	22.5	68	72	69	73	69	73	72	76	72	76	72	76	24			
12.5D	27.5	49	47	49	47	49	47	51	49	51	49	51	49	14			
17.5D	2.5	210	222	212	223	212	223	221	233	223	234	223	235	67			
17.5D	7.5	158	170	159	171	160	171	166	178	167	180	168	180	52			
17.5D	12.5	106	120	107	121	107	121	112	126	113	127	113	127	38			
17.5D	17.5	67	76	68	77	68	77	71	80	71	80	71	81	19			
17.5D	22.5	47	53	47	54	47	54	49	56	50	56	50	56	10			
22.5D	2.5	141	149	142	150	142	151	148	157	149	158	149	158	48			
22.5D	7.5	110	118	110	119	111	119	115	124	116	125	116	125	38			
22.5D	12.5	76	85	77	86	77	86	80	89	81	90	81	90	29			
22.5D	17.5	52	58	52	58	52	58	54	61	55	61	55	61	14			
27.5D	2.5	96	101	96	101	96	101	100	106	101	106	101	107	33			
27.5D	7.5	76	79	77	79	77	80	80	83	81	83	81	84	24			

Complies: ☒ YES ☐ NO

Tested By:	Matthew Benninger				Signature or initials:	mb	Comp. Date	11/27/16
Reviewed By:	cwm				Signature or initials:			
Test Equipment Used:	8,9,10,11							
Amb (°C):	23	RH%	31					

Lens Abrasion Resistance 6.4.5.2

A lens was mounted in the abrasion test fixture with the lens facing upwards. An abrading pad was cycled back and forth (1 cycle) for twelve cycles at $10\text{cm} \pm 2\text{cm}$ per second over the test surface of the lens. The abrading pad shall not be less than $2.5\text{cm} \pm 0.1\text{cm}$ square, constructed of 0000 steel wool rubber cemented to a rigid base shaped to the contour of the lens. The "grain" of the pad was perpendicular to the direction of motion. The abrading pad support was equal in size to the pad and the center of the support surface was within $\pm 2\text{mm}$ of parallel to the lens surface. The density of the abrading pad was such that when the pad was mounted to its support and is resting unweight on the lens, the base of the pad was no closer than 3.2mm to the lens at its closest point. When mounted on its support and resting on the lens, the abrading pad was weighted such that a pad pressure of $14\text{kPa} \pm 1\text{kPa}$ exists at the center and perpendicular to the face of the lens. A pivot was used to follow the contour of the lens.

Results

A single intensity point was measured before and after the abrasion. In all samples tested the abraded lens intensity measurement was at least 90% of the un-abraded lens intensity measurement.

12" Green Ball Tinted			
Sample	Pre Abrasion	Post Abrasion	Percentage
CRT1610241001-006-004	653.5	656.3	100.4
CRT1610241001-006-005	646.0	648.3	100.4
CRT1610241001-008-001	706.5	698.4	98.9

measurements in cd

12" Green Ball Clear			
Sample	Pre Abrasion	Post Abrasion	Percentage
CRT1611071057-002-001	791.3	777.1	98.2
CRT1611071057-002-002	802.6	796.2	99.2
CRT1611071057-002-003	795.5	794.1	99.8

measurements in cd

Measured Voltage:	120.3	Vac		
Measured Weight:	11.0	lbs		
Abrasion Pad	5.5	Sq. In		
Pad Pressure	2.0	psi	13.8	Kpa

Complies: ☒ YES ☐ NO

Tested By:	Matthew Benninger	Signature or initials:	mb/vs	Comp. Date	12/20/2016 & 12/23/16
Reviewed By:	cwm	Signature or initials:	<i>AM</i>		
Test Equipment Used:	8,9,10,11,20				
Amb (°C):	23	RH%	28		

Luminance Uniformity

Luminance measurements were taken at nine locations across the signal face. A spot size of one inch was used. The luminance meter was translated from side to side and up and down remaining normal to the sample surface. The measurements were used to determine luminance uniformity. The measurements were taken after operating on the same duty cycle used during the photometric test.

Results

The ratio between the maximum and the minimum luminance was less than 10 to 1. Data follows.

12" Green Ball Tinted			
Sample	CRT1610241001-006-004	CRT1610241001-006-005	CRT1610241001-008-001
Location	Luminance	Luminance	Luminance
1	1318	1161	1481
2	974	802	844
3	1316	1167	1351
4	589	584	634
5	742	755	758
6	628	908	1312
7	909	800	550
8	1314	916	1123
9	829	739	822
Average	958	870	986
Intensity Ratio	2.2 to 1.0	2.0 to 1.0	2.7 to 1.0

Note: Neutral density filter 1.0 was used for luminance measurements and are relative.

12" Green Ball Clear			
Sample	CRT1611071057-002-001	CRT1611071057-002-002	CRT1611071057-002-003
Location	Luminance	Luminance	Luminance
1	1533	1483	1476
2	919	983	1042
3	1883	1528	1469
4	840	749	694
5	646	777	864
6	1343	728	979
7	629	982	1542
8	1319	1049	922
9	830	834	899
Average	1105	1013	1099
Intensity Ratio	3.0 to 1.0	2.1 to 1.0	2.2 to 1.0

Note: Neutral density filter 1.0 was used for luminance measurements and are relative.

Same 60 minute warm-up used for luminous intensity

Luminance measurements are in cd/m²

Same 60 minute warm-up used for luminous intensity

Test distance is 19 feet with ¼ degree aperture using the PR 740

Measured Voltage:	119.9 - 120.1	Vac
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Complies: ☒ YES ☐ NO

Tested By:	Kurt Dobler	Signature or initials:	kfd	Comp. Date	11/11/16
Reviewed By:	cwm	Signature or initials:	<i>cwm</i>		
Test Equipment Used:	2,3,12,13				
Amb (°C):	22.1	RH%	27		

Chromaticity 6.4.4.6

The chromaticity measurements were performed on the submitted LED Traffic Signal Modules with the spectroradiometer. The samples were operated at nominal input voltage and ambient temperature during the measurements. The measurements were taken from 380-780nm in 2nm increments.

The chromaticity measurements were taken at nine locations across the signal face. A spot size of one inch was used with the samples operating on the same duty cycle used during the photometric test. The spectroradiometer was translated from side to side and up and down remaining normal to the sample surface. The average of the measurements are recorded.

Results

		Chromaticity Coordinates	
Color	Sample	x	y
Green (Tinted)	CRT1610241001-006-004	0.076	0.567
	CRT1610241001-006-005	0.078	0.567
	CRT1610241001-008-001	0.074	0.553

		Chromaticity Coordinates	
Color	Sample	x	y
Green (Clear)	CRT1611071057-002-001	0.082	0.529
	CRT1611071057-002-002	0.083	0.545
	CRT1611071057-002-003	0.085	0.556

The chromaticity measurements pass the requirements of the referenced specification.

Measured Voltage:	119.9 - 120.1	Vac
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Complies: ☒ YES ☐ NO

Tested By:	Kurt Dobler/John Robins	Signature or initials:	kfd JR	Comp. Date	11/11/16
Reviewed By:	cwm	Signature or initials:	AM		
Test Equipment Used:	2,3,12,13				
Amb (°C):	22.1	RH%	27		

Color Uniformity 6.4.4.7

Three samples of each model were tested. Nine color measurements were taken at different locations on the traffic signal face. The measurements were taken after operating on the same duty cycle used during the photometric test. The dominant wave length was found using the measured (x, y) coordinates and table 3.29 of "Color Science" by Wyszecki & Stiles.

Results

12" Green Ball Tinted

Sample	CRT1610241001-006-004			CRT1610241001-006-005			CRT1610241001-008-001		
Location	x	y	Dominant	x	y	Dominant	x	y	Dominant
1	0.075	0.568	504	0.077	0.572	504	0.073	0.551	503
2	0.077	0.574	504	0.079	0.571	504	0.075	0.561	504
3	0.076	0.564	504	0.079	0.568	504	0.075	0.554	503
4	0.075	0.569	504	0.078	0.565	504	0.073	0.552	503
5	0.073	0.554	503	0.077	0.555	503	0.072	0.540	502
6	0.078	0.581	505	0.081	0.584	504	0.075	0.559	503
7	0.078	0.580	505	0.082	0.579	504	0.077	0.568	504
8	0.075	0.563	504	0.079	0.567	504	0.075	0.557	503
9	0.072	0.545	503	0.074	0.542	502	0.071	0.534	502
Average	0.076	0.567	504	0.078	0.567	504	0.074	0.553	503

12" Green Ball Clear

Sample	CRT1611071057-002-001			CRT1611071057-002-002			CRT1611071057-002-003		
Location	x	y	Dominant	x	y	Dominant	x	y	Dominant
1	0.083	0.533	502	0.083	0.550	503	0.086	0.562	504
2	0.083	0.528	502	0.084	0.547	503	0.086	0.557	504
3	0.083	0.530	502	0.083	0.545	503	0.085	0.552	504
4	0.081	0.523	502	0.082	0.539	503	0.084	0.549	503
5	0.081	0.528	502	0.081	0.542	503	0.088	0.575	505
6	0.084	0.540	503	0.086	0.564	504	0.088	0.564	505
7	0.084	0.540	503	0.086	0.556	504	0.086	0.557	504
8	0.082	0.524	502	0.083	0.543	503	0.084	0.548	503
9	0.079	0.514	501	0.079	0.522	502	0.081	0.538	503
Average	0.082	0.529	502	0.083	0.545	503	0.085	0.556	504

Measured Voltage:	119.9 - 120.1	Vac
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Complies:	<input checked="" type="checkbox"/> YES	<input type="checkbox"/> NO
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Tested By:	Kurt Dobler/John Robins	Signature or initials:	kfd <i>JR</i>	Comp. Date	11/11/16
Reviewed By:	cwm	Signature or initials:	<i>cwm</i>		
Test Equipment Used:	2,3,12,13				
Amb (°C):	22.1	RH%	27		

Current Consumption 6.4.6.1

Three samples were measured for current flow in amperes. The measured current values are supplied for comparison of Product Quality Assurance current measurements on production modules. Current measurements were taken at start up.

Results

Measurements are in (mA)

12" Green Ball			
Sample	-40°C	25°C	74°C
CRT1610241001-006-001	74.7	65.2	62.2
CRT1610241001-006-002	76.1	66.9	62.1
CRT1610241001-006-003	74.5	65.2	61.8

The current consumption was not in excess of 120% of the label current values for an ambient temperature of 25°C.

Measured Voltage:	120.1	Vac
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Complies: ☒ YES ☐ NO

Tested By:	John Robins	Signature or initials:	<i>JR</i>	Comp. Date	11/10/16
Reviewed By:	cwm	Signature or initials:	<i>cwm</i>		
Test Equipment Used:	1,15				
Amb (°C):	na	RH%	na		

Low Voltage Turn Off 6.4.6.2

Three samples were measured to ensure compliance with the low voltage turn-off requirement. Each sample was fully illuminated at the nominal operating voltage. The applied voltage was then reduced to the point where there was no visible illumination.

Results

There was no visible illumination when the applied voltage was less than 35Vac RMS.

12" Green Ball	
Sample	Low Voltage Turn Off (Vac RMS)
CRT1610241001-006-001	65.3
CRT1610241001-006-002	64.8
CRT1610241001-006-003	64.2

Complies: ☒ YES ☐ NO

Tested By:	Kurt Dobler	Signature or initials:	kfd	Comp. Date	11/9/16
Reviewed By:	cwm	Signature or initials:	<i>cwm</i>		
Test Equipment Used:	2,16				
Amb (°f):	72	RH%	37		

Turn-On/Turn-Off Times 6.4.6.3

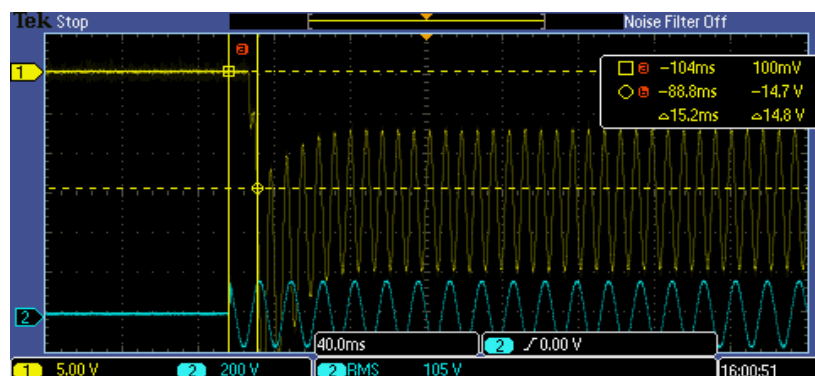
Three samples were measured to ensure compliance with the turn-on and turn-off requirements. The measurements were conducted using a two channel oscilloscope to measure the time delay between when the samples are energized at 120 Vac RMS and when the light output reaches 90% of full output. The same test equipment was used to measure the time delay between when the sample is de-energized and when the light output reaches 0% of full output.

Results

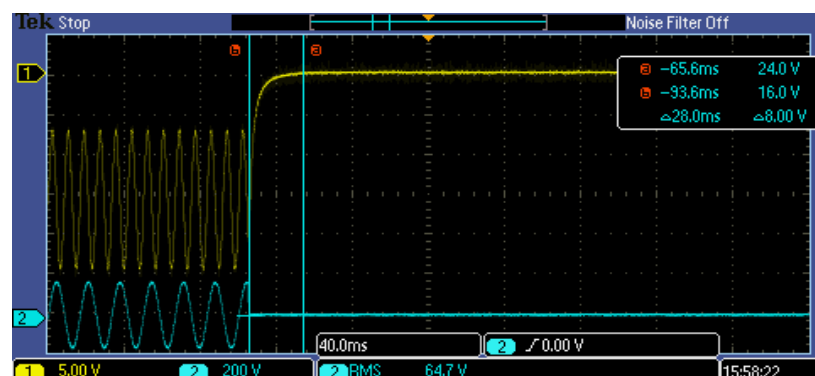
12" Green Ball		
Sample	Turn On	Turn Off
CRT1610241001-006-001	15.2	28.0
CRT1610241001-006-002	12.0	24.8
CRT1610241001-006-003	10.4	24.8

The "on" time and "off" time were within the 75ms requirement on all samples tested.

Sample Turn On Time



Sample Turn Off Time



Measured Voltage: 120 Vac

Complies: ☒ YES ☐ NO

Tested By:	John Robins	Signature or initials:	<i>JR</i>	Comp. Date:	12/6/16
Reviewed By:	cwm	Signature or initials:	<i>cwm</i>		
Test Equipment Used:	16,18,19				
Amb (°f):	72	RH%	27		

Transient Voltage Immunity 6.4.6.4

Three samples were subjected to 3 positive and 3 negative 1000V 7.5 joule pulses across their input leads at a rate of 0.5 pps in accordance with NEMA TS 2-2003 section 2.1.8. The pulses were the discharge from a 15 μ F capacitor. The devices were then energized with rated voltage to verify proper operation.

Results

The signal modules withstood the applications of the transient voltage without damage or operational deterioration.

12" Green Ball			
Sample	3 Positive Pulses	3 Negative Pulses	Results
CRT1610241001-006-001	x	x	Pass
CRT1610241001-006-002	x	x	Pass
CRT1610241001-006-003	x	x	Pass

Measured Voltage:	1000	Vdc
Measured Capacitance:	15.8 - 16.6	μ F

Complies: ☒ YES ☐ NO

Tested By:	Kurt Dobler	Signature or initials:	kfd	Comp. Date	12/8/16
Reviewed By:	cwm	Signature or initials:	<i>AM</i>		
Test Equipment Used:	2,16				
Amb (°C):	72	RH%	30		

Electronic Noise 6.4.6.5

Three LED traffic signal modules were operated at 120 VAC/60Hz throughout the test. Emissions measurements were taken to compare values to applicable requirements.

Results

The emissions complied with the requirements of the referenced specification. The testing was performed at our Oakdale, MN office. See report: 102472631MIN-014G

Complies: ☒ YES ☐ NO

Tested By:	Richard Blonigen	Signature or initials:	See Report	Comp. Date	12/21/16
Reviewed By:	Uri Spector	Signature or initials:	See Report		
Test Equipment Used:	See Report				
Amb (°C):	See Report	RH%	See Report		

Power Factor & Total Harmonic Distortion 6.4.6.6 & 6.4.6.7

Three tinted samples were measured for power factor and total harmonic distortion. A commercially available power analyzer was used to perform these measurements.

Results

12" Green Ball						
Sample	Voltage	Current (mA)	Power (W)	Power Factor	THD V%	THD I%
CRT1610241001-006-001	120.0	64.0	7.4	0.97	0.75	14.7
CRT1610241001-006-002	120.0	65.5	7.6	0.97	0.78	14.4
CRT1610241001-006-003	120.0	64.0	7.4	0.96	0.75	14.6
Requirement	NA	NA	NA	≥ 0.90	≤ 20%	≤ 20%

Measurements taken after a minimum 60 minute warmup.

Complies: ☒ YES ☐ NO

Tested By:	John Robins	Signature or initials:	<i>JR</i>	Comp. Date	11/8/16
Reviewed By:	cwm	Signature or initials:	<i>cwm</i>		
Test Equipment Used:	15,16				
Amb (°f):	72	RH%	30		

Load Switch Compatibility 6.4.7.1

Three samples were connected to a variable AC voltage supply. The sample was monitored for sufficient current draw to ensure proper load switch operation while the voltage is varied from 80V rms to 135 V rms.

Results

The load switch data is provided to the client to determine if the current draw is acceptable. The referenced ITE specification does not list a minimum current draw requirement. As a result, the Caltrans Standard Specifications dated 2010, Section 86-4.01D(2)(a) must be followed listing a minimum power consumption requirement of 5 watts for 12" traffic signal modules.

12" Green Ball		
Sample	80 Vrms	135 Vrms
CRT1610241001-006-001	91.1	64.7
CRT1610241001-006-002	93.8	65.2
CRT1610241001-006-003	90.8	65.5



Current measurements are in mA

12" Green Ball		
Sample	80 Vrms	135 Vrms
CRT1610241001-006-001	7.0	7.8
CRT1610241001-006-002	7.2	7.9
CRT1610241001-006-003	7.0	7.7

Power measurements are in watts.

Measured Voltage 80Vac:	80.1	Vac
Measured Voltage 135Vac:	135.0	Vac

Complies: ☒ YES ☐ NO

Tested By:	John Robins	Signature or initials:		Comp. Date	11/9/16
Reviewed By:	cwm	Signature or initials:			
Test Equipment Used:	15,16				
Amb (°f):	73	RH%	38		

Off State Voltage Decay 6.4.7.2

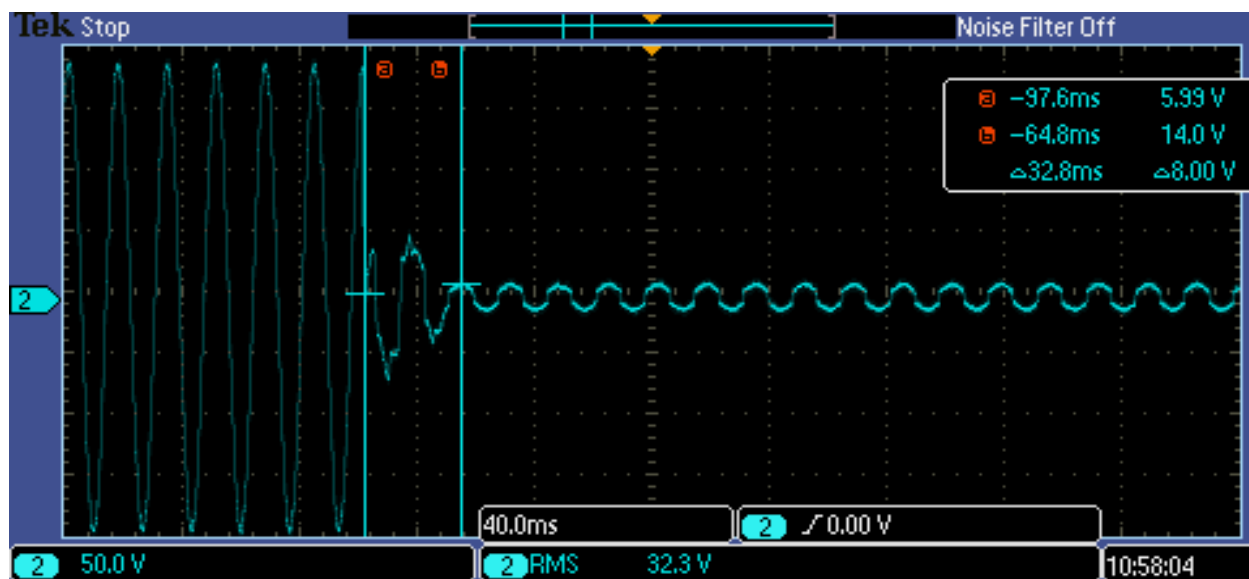
Three samples were operated from a 135V AC voltage supply. A 19.5 k-ohm resistor was wired in series in the hot line between the LED signal monitor and the AC power supply. A single-pole-single-throw switch was wired in parallel across the 19.5 k-ohm resistor. A 220 k-ohm shunt resistor was wired between the hot line connection and the neutral line connection on the LED signal module. The single-pole-single-throw switch was closed, shorting out the 19.5 k-ohm resistor, allowing the AC power supply to illuminate the LED signal module. Next the switch was opened and the voltage across the 220 k-ohm shunt resistor was measured for a decay to a value equal to or less than 10V rms within a time period equal to or less than 100 milliseconds. The test was repeated a sufficient number of times to ensure testing occurs at the peak of the AC line voltage cycle.

Results

12" Green Ball	
sample	Decay Time (mS)
CRT1610241001-006-001	31.2
CRT1610241001-006-002	31.2
CRT1610241001-006-003	32.8

In all samples measured the decay time was less than 100mS.

Sample Screen Shot



Measured Voltage: 135 Vac

Complies: ☒ YES ☐ NO

Tested By:	John Robins	Signature or initials:	<i>JR</i>	Comp. Date	12/7/16
Reviewed By:	cwm	Signature or initials:	<i>cwm</i>		
Test Equipment Used:	16,18,19				
Amb (°C):	72	RH%	29		

Failed State Impedance 6.4.8

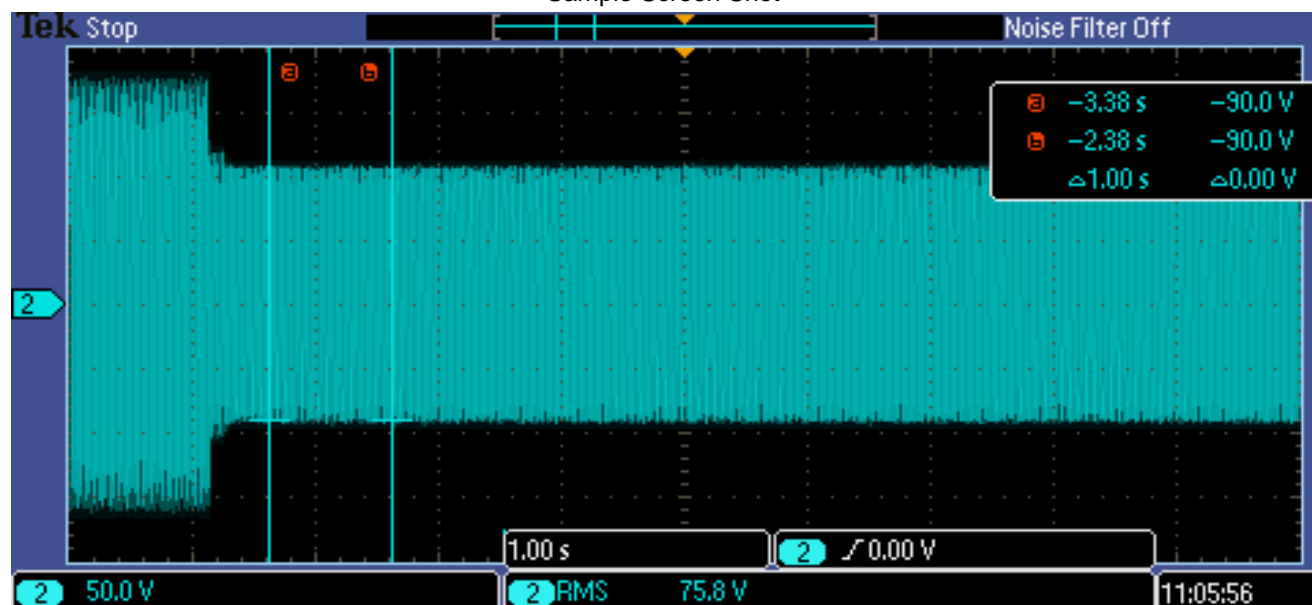
First the LED board is disconnected from the signal power supply. Then the LED signal modules are operated from a 120V AC voltage supply. A 50k-ohm resistor is wired in series in the hot line between the LED signal module and the AC power supply. A single-pole-single-throw switch is wired in parallel across the 50k-ohm resistor. A 100 k-ohm shunt resistor is wired between the hot line connection and the neutral line connection on the LED signal module. The single-pole-single-throw switch is opened and the voltage across the 100 k-ohm shunt resistor is measured from 500mS through 1500mS, after energizing the circuit with the open switch. The test was repeated 10 times.

Results

12" Green Ball	
sample	Vrms
CRT1610241001-006-001	75.8
CRT1610241001-006-002	76.1
CRT1610241001-006-003	75.9

In all samples tested the voltage across the 100KΩ resistor was greater than 70 Vac RMS.

Sample Screen Shot



Measured Voltage: 120 Vac

Complies: ☒ YES ☐ NO

Tested By:	John Robins	Signature or initials:	<i>JR</i>	Comp. Date	2/27/17
Reviewed By:	JND	Signature or initials:	<i>JND</i>		
Test Equipment Used:	16,18,19				
Amb (°f):	72	RH%	24		

Equipment list

#	Intertek ID No.	Description	Manufacturer	Calibration Due
1	H204	Chamber	Thermotron	10-Nov-2017
2	M207	Digital Multimeter	Fluke	17-Sep-2017
3	T1486	Digit Hygro-Thermometer	Extech	16-Mar-2017
4	V272	Signal Conditioner	Unholtz-Dickie	27-Jun-2017
5	V393	Vibration Controller	Unholtz-Dickie	15-Jul-2017
6	V328	Accelerometer	PCB Piezotronics	2-Dec-2016
7	V334	Accelerometer	PCB Piezotronics	18-Feb-2017
8	O109	Goniometer	Optroniks	3-Oct-2017
9	O115	25M Photometer	Optroniks	24-Oct-2017
10	T1555	Hygro-Thermometer	Extech	3-May-2017
11	M135	Multimeter	Fluke	4-Apr-2017
12	O757	Spectra Scan	Photo Research	23-Mar-2017
13	R153	Distance Meter	Leica	7-Dec-2016
14	O719	flexOptometer	UDT	3-Dec-2016
15	G032S	Power Analyzer	Yokogawa	9-May-2017
16	T835	Temp/Humidity	Supco	10-Jun-2017
17	T804	Digital Thermometer	Fluke	16-May-2017
18	V244	High Voltage Probe	Tektronix	3-Nov-2017
19	E470	Oscilloscope	Tektronix	8-Jul-2017
20	S159	Push Pull Scale	Controls International	7-Jan-2017
21	N1153	Rain Gauge	Pyrex	6-Jan-2019
22	T804	Thermometer	Fluke	16-May-2017
23	N1419	Stopwatch	Control Co	16-Aug-2017
24	Y205	Anemometer	Omega	23-May-2017

Note: For measurement uncertainty, refer to the calibration certificates for all the test equipment located in the equipment files



Issue Date: March 23, 2017
Project No. G102785964
Quote No.: Qu-00734330

Contact: Hamid Kashani
Email: hamid@leotek.com
Phone No. 408-380-1788

Report No. 102785964CRT-001R

Leotek Electronics USA LLC

1955 Lundy Ave
San Jose, CA 95131

Standards

Performance Specification of the Institute of Transportation Engineers, Vehicle Traffic Control Signal Heads: Light Emitting Diode (LED) Vehicle Arrow Traffic Signal Supplement, dated July 1, 2007.

Standard Specifications Caltrans dated 2010. Section 86-4.01D(2)(a)

Test Purpose	ITE 5-Year Re-Certification Testing of Models; TSL-12RA-IL6-A1 & TSL-12RA-IL6-A1-CLR
Test Dates	October 27, 2016 through March 23, 2017

John C. Robins
Engineer
Lighting

Christopher W. Metcalf
Engineering Supervisor
Lighting

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Test Plan and Datasheets			
Client	Leotek Electronics USA LLC	Engineer	John C. Robins
Report #	102785964CRT-001R	Reviewer	Christopher W. Metcalf
Product	12" Red Omni Arrow Tinted & Clear	Model(s)	TSL-12RA-IL6-A1 & TSL-12RA-IL6-A1-CLR
Standard	ITE, Vehicle Arrow Traffic Signal Supplement, dated July 1, 2007.		

Spec	Test name	Clause	Pass Fail NA
ITE	Conditioning	6.4.2	Pass
ITE	Mechanical Vibration	6.4.3.1	Pass
ITE	Temperature Cycling	6.4.3.2	Pass
ITE	Moisture Resistance	6.4.3.3	Pass
ITE	Luminous Intensity	6.4.4.1, 2,3,4	Pass
ITE	Luminance Uniformity	6.4.4.5	Pass
ITE	Chromaticity	6.4.4.6	Pass
ITE	Color Uniformity	6.4.4.7	Pass
ITE	Lens Abrasion Resistance	6.4.5.2	Pass
ITE	Current Consumption	6.4.6.1	Pass
ITE	Low Voltage Turn Off	6.4.6.2	Pass
ITE	Turn-On/Turn-Off Times	6.4.6.3	Pass
ITE	Transient Voltage Immunity	6.4.6.4	Pass
ITE	Electronic Noise	6.4.6.5	Pass
ITE	Power Factor & Total Harmonic Distortion	6.4.6.6, 7	Pass
ITE	Load Switch Compatibility	6.4.7.1	Pass
ITE	Off State Voltage Decay	6.4.7.2	Pass
ITE	Failed State Impedance	6.4.8	Pass

Sample Information				
Date Rec.	Intertek ID	Description	Condition	Model No.
10/24/2016	CRT1610241001-005	12" Red Omni Arrow Tinted	Production	TSL-12RA-IL6-A1
10/24/2016	CRT1610241001-002	12" Red Omni Arrow Tinted	Production	TSL-12RA-IL6-A1
11/7/2016	CRT1611071057-001	12" Red Omni Arrow Clear	Production	TSL-12RA-IL6-A1-CLR
2/21/2017	CRT1702211015-003	12" Red Omni Arrow Tinted	Production	TSL-12RA-IL6-A1

Further Sample Description

Intertek Sample Number	Description	Model Number	Serial Number
CRT1610241001-005-001	12" Red Omni Arrow Tinted	TSL-12RA-IL6-A1	16917539
CRT1610241001-005-002	12" Red Omni Arrow Tinted	TSL-12RA-IL6-A1	16917540
CRT1610241001-005-003	12" Red Omni Arrow Tinted	TSL-12RA-IL6-A1	16917541
CRT1610241001-005-004	12" Red Omni Arrow Tinted	TSL-12RA-IL6-A1	16917542
CRT1610241001-005-005	12" Red Omni Arrow Tinted	TSL-12RA-IL6-A1	16917543
CRT1610241001-002-001	12" Red Omni Arrow Tinted	TSL-12RA-IL6-A1	16917544
CRT1611071057-001-003	12" Red Omni Arrow Clear	TSL-12RA-IL6-A1-CLR	T16B019
CRT1611071057-001-004	12" Red Omni Arrow Clear	TSL-12RA-IL6-A1-CLR	T16B020
CRT1611071057-001-005	12" Red Omni Arrow Clear	TSL-12RA-IL6-A1-CLR	T16B021
CRT1702211015-003-005	12" Red Omni Arrow Tinted	TSL-12RA-IL6-A1	16B18888

General Requirements

Intertek Sample Number	ETL Cert. Number	Label Identification	Lens Orientation	Color Coded Wires
CRT1610241001-005-001	7080609	Pass	Pass	Red/White
CRT1610241001-005-002	7080610	Pass	Pass	Red/White
CRT1610241001-005-003	7080611	Pass	Pass	Red/White
CRT1610241001-005-004	7080612	Pass	Pass	Red/White
CRT1610241001-005-005	7080613	Pass	Pass	Red/White
CRT1610241001-002-001	7080614	Pass	Pass	Red/White
CRT1611071057-001-003	6596097	Pass	Pass	Red/White
CRT1611071057-001-004	6596101	Pass	Pass	Red/White
CRT1611071057-001-005	6596096	Pass	Pass	Red/White
CRT1702211015-003-005	7129829	Pass	Pass	Red/White

General Requirements

Intertek Sample Number	600V / 20 AWG Min.	Wire Length \geq 39"	Service Rating \pm 105°C
CRT1610241001-005-001	600V/18AWG	Pass	Pass
CRT1610241001-005-002	600V/18AWG	Pass	Pass
CRT1610241001-005-003	600V/18AWG	Pass	Pass
CRT1610241001-005-004	600V/18AWG	Pass	Pass
CRT1610241001-005-005	600V/18AWG	Pass	Pass
CRT1610241001-002-001	600V/18AWG	Pass	Pass
CRT1611071057-001-003	600V/18AWG	Pass	Pass
CRT1611071057-001-004	600V/18AWG	Pass	Pass
CRT1611071057-001-005	600V/18AWG	Pass	Pass
CRT1702211015-003-005	600V/18AWG	Pass	Pass

Picture(s)



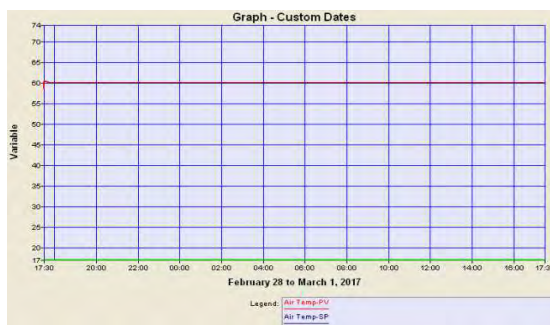
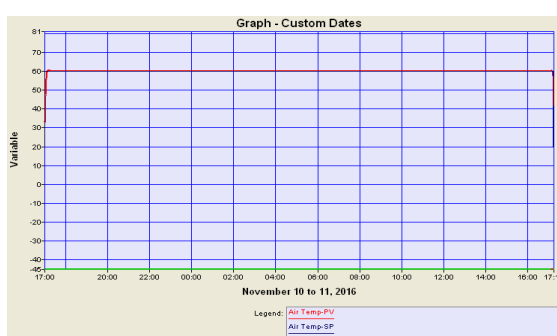
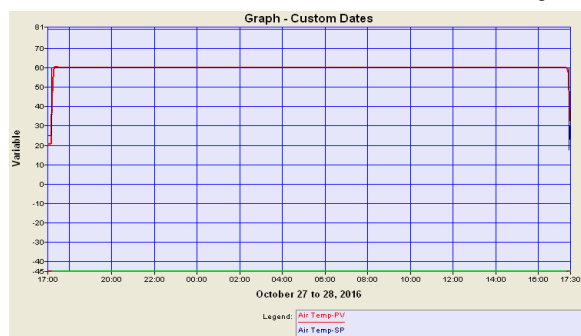
Conditioning 6.4.2

The submitted LED signal modules were subjected to conditioning prior to the environmental tests. The samples were energized for a minimum of 24 hours, at 100% duty cycle in an ambient temperature of +60°C (+140°F). At the conclusion of the test, the modules shall be visually inspected for damage and checked for proper operation.

Results

Intertek Sample Number	Description	Visual Inspection		Operational Check	
		Pre	Post	Pre	Post
CRT1610241001-005-001	12" Red Omni Arrow Tinted	Pass	Pass	Pass	Pass
CRT1610241001-005-002	12" Red Omni Arrow Tinted	Pass	Pass	Pass	Pass
CRT1610241001-005-003	12" Red Omni Arrow Tinted	Pass	Pass	Pass	Pass
CRT1610241001-005-004	12" Red Omni Arrow Tinted	Pass	Pass	Pass	Pass
CRT1610241001-005-005	12" Red Omni Arrow Tinted	Pass	Pass	Pass	Pass
CRT1610241001-002-001	12" Red Omni Arrow Tinted	Pass	Pass	Pass	Pass
CRT1611071057-001-003	12" Red Omni Arrow Clear	Pass	Pass	Pass	Pass
CRT1611071057-001-004	12" Red Omni Arrow Clear	Pass	Pass	Pass	Pass
CRT1611071057-001-005	12" Red Omni Arrow Clear	Pass	Pass	Pass	Pass
CRT1701031258-001-001	12" Red Omni Arrow Tinted	Pass	Pass	Pass	Pass

Conditioning Screen Shots



Measured Voltage: 119.3 -120.8 Vac

Complies: ☒ YES ☐ NO

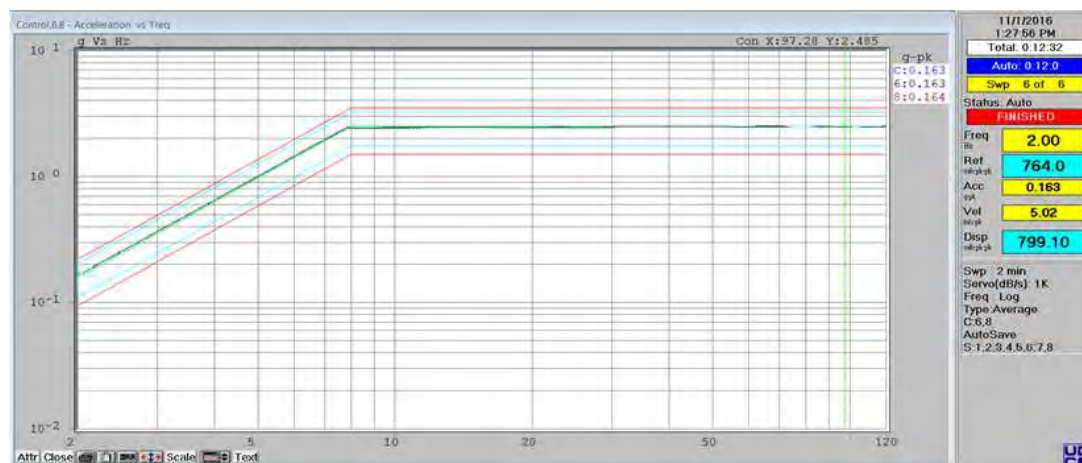
Tested By:	John Robins	Signature or initials:	<i>JR</i>	Comp. Date:	3/1/17
Reviewed By:	cwm	Signature or initials:	<i>cwm</i>		
Test Equipment Used:	1,2				
Amb (°C):	na	RH%:	na		

Mechanical Vibration 6.4.3.1

The submitted LED signal modules were securely mounted in traffic signal housings and vibrated along each axes for three 4 minute sweep cycles at a displacement of 0.764" from 2 to 8 Hz and 2.5 Gs from 8 to 120 Hz. The modules were energized before and after each axis sweep. The modules were visually inspected after testing. Testing was conducted in accordance with MIL-STD-883, method 2007. At the conclusion of the test, the module shall be free of damage and fully operational.

Results

Intertek Sample Number	Description	x-axis lateral	y-axis horizontal	z-axis vertical	Visual Inspection	Operational Check
CRT1610241001-005-001	12" Red Omni Arrow Tinted	X	X	X	Pass	Pass
CRT1610241001-005-002	12" Red Omni Arrow Tinted	X	X	X	Pass	Pass
CRT1610241001-005-003	12" Red Omni Arrow Tinted	X	X	X	Pass	Pass
CRT1610241001-005-004	12" Red Omni Arrow Tinted	X	X	X	Pass	Pass
CRT1610241001-005-005	12" Red Omni Arrow Tinted	X	X	X	Pass	Pass
CRT1610241001-002-001	12" Red Omni Arrow Tinted	X	X	X	Pass	Pass

Complies: ☒ YES ☐ NO

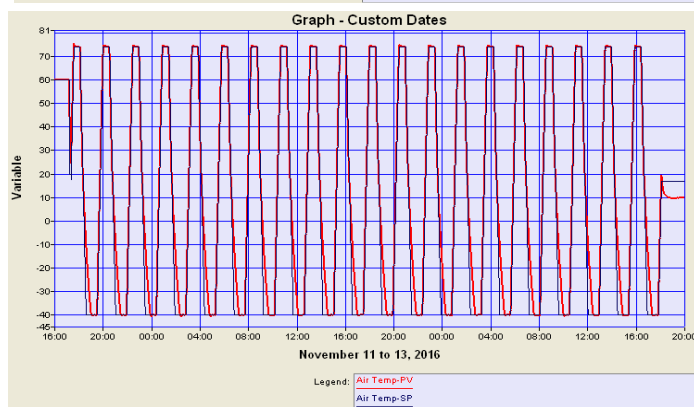
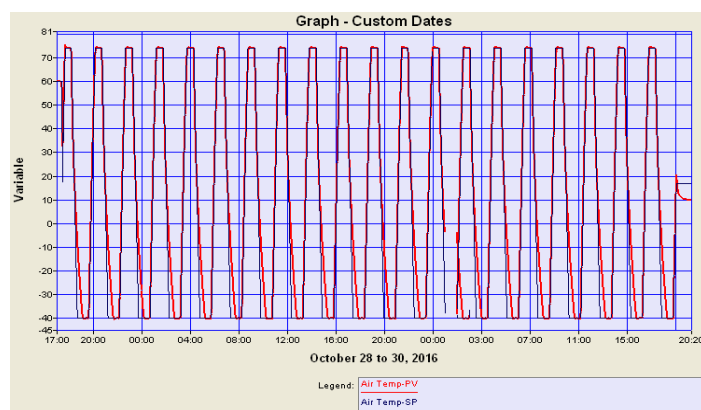
Tested By:	Gordon West	Signature or initials:	<i>Gordon West</i>	Comp. Date	11/2/16
Reviewed By:	cwm	Signature or initials:	<i>cwm</i>		
Test Equipment Used:	3,4,5,6,7				
Amb (°C):	22.3	RH%	33		

Temperature Cycling 6.4.3.2

The submitted tinted and clear LED signal modules were subjected to temperature cycling according to MIL-STD-883, Method 1010. Twenty cycles were performed with a 30 minute transfer time between temperature extremes and a 30 minute dwell time at the extremes. The temperature cycled between -40°C and +74°C. The samples were non-operating. At the conclusion of the test, the module shall be free of damage and moisture and be fully operational.

Results

Intertek Sample Number	Description	Visual Inspection	Operational Check
CRT1610241001-005-001	12" Red Omni Arrow Tinted	Pass	Pass
CRT1610241001-005-002	12" Red Omni Arrow Tinted	Pass	Pass
CRT1610241001-005-003	12" Red Omni Arrow Tinted	Pass	Pass
CRT1610241001-005-004	12" Red Omni Arrow Tinted	Pass	Pass
CRT1610241001-005-005	12" Red Omni Arrow Tinted	Pass	Pass
CRT1610241001-002-001	12" Red Omni Arrow Tinted	Pass	Pass
CRT1611071057-001-003	12" Red Omni Arrow Clear	Pass	Pass
CRT1611071057-001-004	12" Red Omni Arrow Clear	Pass	Pass
CRT1611071057-001-005	12" Red Omni Arrow Clear	Pass	Pass



Complies: ☒ YES ☐ NO

Tested By:	John Robins	Signature or initials:	<i>JR</i>	Comp. Date	10/30/16
Reviewed By:	cwm	Signature or initials:	<i>cwm</i>		
Test Equipment Used:	1				
Amb (°C):	na	RH%	na		

Moisture Resistance 6.4.3.3

The submitted tinted and clear LED signal modules were subjected to the rain and blowing rain test per MIL-STD-810F, Test Method 506.4, Procedure I. The test was performed on standalone modules without a protective housing. The rainfall rate was 1.7 mm/min (4in/hr) and the droplet size shall predominantly be between 0.5mm and 4.5mm (0.02 to 0.18 in). The samples were oriented such that the lens is directed towards the wind source when at a zero rotation angle. The samples were rotated at a rate of 4 degrees per minute along the vertical axis, from an orientation of -60 to +60 degrees during the test. The duration of the test is 30 minutes, and the samples were energized throughout the test. The water temperature was $25^{\circ} \pm 5^{\circ}\text{C}$ ($77^{\circ} \pm 9^{\circ}\text{F}$) and the wind velocity was 80 km/hr (50 mph). At the conclusion of the test, the module shall be free of damage and moisture and be fully operational.

Results

Intertek Sample Number	Description	Visual Inspection	Operational Check
CRT1610241001-005-001	12" Red Omni Arrow Tinted	pass	pass
CRT1610241001-005-002	12" Red Omni Arrow Tinted	pass	pass
CRT1610241001-005-003	12" Red Omni Arrow Tinted	pass	pass
CRT1610241001-005-004	12" Red Omni Arrow Tinted	pass	pass
CRT1610241001-005-005	12" Red Omni Arrow Tinted	pass	pass
CRT1610241001-002-001	12" Red Omni Arrow Tinted	pass	pass
CRT1611071057-001-003	12" Red Omni Arrow Clear	pass	pass
CRT1611071057-001-004	12" Red Omni Arrow Clear	pass	pass
CRT1611071057-001-005	12" Red Omni Arrow Clear	pass	pass

Requirement: Signal Still Operational and No Moisture In The Housing

Intertek Sample Number	Sample Temp. at start (°C)	Water Temperature 25C +/- 5C			
		Start	10 minutes in.	20 minutes in.	30 minutes in.
CRT1610241001-005-001	40	28.4	29.0	27.0	28.2
CRT1610241001-005-002	40				
CRT1610241001-005-003	40	29.4	28.2	23.8	28.9
CRT1610241001-005-004	40	28.8	27.5	27.0	26.4
CRT1610241001-005-005	40	24.6	26.9	23.7	22.7
CRT1610241001-002-001	40				
CRT1611071057-001-003	40	22.0	29.7	29.5	23.9
CRT1611071057-001-004	40				
CRT1611071057-001-005	40	28.8	27.5	27.0	26.4

* Water temperature is °C

Recorded rainfall rate:	4.3	in/hr
Recorded wind velocity:	48-52	mph

Complies: ☒ YES ☐ NO

Tested By:	Kurt Dobler	Signature or initials:	kfd	Comp. Date	1/26/17
Reviewed By:	cwm	Signature or initials:	<i>cwm</i>		
Test Equipment Used:	15,16,17,18				
Amb (°C):	na	RH%	na		

The intensity distribution tests on the submitted LED traffic signal modules were performed with the Intertek 25 meter Goniophotometer. The goniophotometer was in accordance with the goniometer described in Section 11.02 (Test Apparatus) of the Institute of Transportation Engineers' Vehicle Traffic Control Signal Heads Standard Test Method. The calibration of the goniophotometer is traceable to the National Institute of Standards and Technology. The LED modules were operated at 120 volts AC. The alignment of the LED module was performed in accordance with Section 11.03 (Alignment of Optical Unit for Test) of the Institute of Transportation Engineers' Vehicle Traffic Control Signal Heads Standard Test Method. The submitted LED signal modules were tested for maintained minimum luminous intensity at each of 112 points indicated in Table 3, of the referenced specification. These measurements were recorded at an ambient temperature of 25°C. The red LED signal modules were energized at nominal operating voltage, at a 100% duty cycle for 60 minutes.

A relative luminous intensity measurement is taken in a region from 0 to 7.5° down, and from 7.5° left to 7.5° right. The measurement is taken at 80 Vac, 120 Vac and 135 Vac. When the 80 Vac and 135 Vac factors are applied to the photometric data the units shall still meet the photometric requirements of each model.

A diminution factor was measured by using the submitted samples. The modules were mounted in a dual compartment temperature chamber with the lensed portion in one compartment and all portions behind the lens within the other compartment. At room ambient temperature (both inside and outside the chamber) and in calm air outside the chamber, the modules were energized per the conditions described above and a single on-axis reading (IA) taken and recorded. With the modules off, the chamber was heated to 74°C behind the lens and 49°C in front of the lens, and allowed to stabilize. Following stabilization, the modules were energized per the above cycle and the single on-axis reading (IH) taken and recorded. A diminution factor was calculated (IH/IA). The readings recorded initially were factored by the diminution factor.

Luminous Intensity 6.4.4.1 through 6.4.4.4

Sample	CRT1610241001-005-004				Target Input voltage		Measured Input Voltage		0, 0 Lum. Intensity		Vac Variation Factor		MMLI Factor	
Module	12" Omni Arrow				80Vac		80.2 Vac		109.7 Candela		0.995		0.695	
Color:	Red				120Vac		120.3 Vac		110.3 Candela		1.000			
Lens	Tinted				135Vac		135.5 Vac		111.3 Candela		1.009			
Photometric Test Distance: 5 meters														
Max	175.2	25°C		25°C		25°C		74°C/49°C		74°C/49°C		74°C/49°C		
Vertical	Horizontal	Rated 80Vac		Measured 120Vac		Rated 135Vac		Rated 80Vac		Measured 120Vac		Rated 135Vac		Table 3
Angle	Angle	Candela	Candela	Candela	Candela	Candela	Candela	Candela	Candela	Candela	Candela	Candela	Candela	Minimum
Up/Down	Left/Right	Left	Right	Left	Right	Left	Right	Left	Right	Left	Right	Left	Right	Candela
27.5U	7.5	7.6	7.6	7.6	7.7	7.7	7.7	5.3	5.3	5.3	5.3	5.4	5.4	2.8
27.5U	2.5	9.1	9.0	9.1	9.0	9.2	9.1	6.3	6.2	6.3	6.3	6.4	6.3	3.3
22.5U	17.5	5.7	6.3	5.7	6.4	5.8	6.4	3.9	4.4	4.0	4.4	4.0	4.5	2.9
22.5U	12.5	8.6	8.9	8.7	9.0	8.7	9.0	6.0	6.2	6.0	6.2	6.1	6.3	5.0
22.5U	7.5	12.7	13.1	12.8	13.2	12.9	13.3	8.8	9.1	8.9	9.2	9.0	9.2	7.1
22.5U	2.5	16.5	16.7	16.6	16.8	16.9	16.9	11.5	11.6	11.6	11.7	11.7	11.8	8.5
17.5U	22.5	5.9	6.4	5.9	6.5	6.0	6.5	4.1	4.5	4.1	4.5	4.1	4.5	2.9
17.5U	17.5	9.0	9.5	9.0	9.6	9.1	9.7	6.2	6.6	6.3	6.7	6.3	6.7	6.0
17.5U	12.5	15.3	15.7	15.4	15.8	15.5	15.9	10.6	10.9	10.7	11.0	10.8	11.1	10.5
17.5U	7.5	26.7	26.3	26.8	26.5	27.0	26.7	18.5	18.3	18.6	18.4	18.8	18.6	15.1
17.5U	2.5	36.3	36.0	36.5	36.2	36.8	36.6	25.2	25.0	25.4	25.2	25.6	25.4	18.2
12.5U	22.5	8.5	9.3	8.5	9.4	8.6	9.5	5.9	6.5	5.9	6.5	6.0	6.6	5.0
12.5U	17.5	15.2	16.3	15.3	16.4	15.4	16.6	10.6	11.3	10.6	11.4	10.7	11.5	10.5
12.5U	12.5	29.2	30.7	29.4	30.9	29.6	31.1	20.3	21.3	20.4	21.4	20.6	21.6	18.3
12.5U	7.5	50.8	49.7	51.1	49.9	51.6	50.4	35.3	34.5	35.5	34.7	35.8	35.0	26.7
12.5U	2.5	67.2	67.4	67.6	67.8	68.2	68.4	46.7	46.9	47.0	47.1	47.4	47.5	32.1
7.5U	27.5	6.7	7.6	6.8	7.6	6.8	7.7	4.7	5.3	4.7	5.3	4.8	5.3	2.8
7.5U	22.5	13.1	15.2	13.2	15.3	13.3	15.4	9.1	10.6	9.2	10.6	9.2	10.7	7.1
7.5U	17.5	26.3	30.6	26.4	30.7	26.6	31.0	18.2	21.2	18.3	21.4	18.5	21.6	15.1
7.5U	12.5	50.9	52.4	51.2	52.6	51.6	53.1	35.4	36.4	35.6	36.6	35.9	36.9	26.7
7.5U	7.5	80.4	76.4	80.9	76.8	81.6	77.5	55.9	53.1	56.2	53.4	56.7	53.9	38.9
7.5U	2.5	96.3	92.4	96.8	92.9	97.7	93.7	66.9	64.2	67.3	64.6	67.9	65.1	47.0
2.5U	27.5	8.4	10.6	8.5	10.6	8.5	10.7	5.8	7.3	5.9	7.4	5.9	7.4	3.3
2.5U	22.5	20.0	24.1	20.1	24.2	20.3	24.4	13.9	16.7	14.0	16.8	14.1	17.0	8.5
2.5U	17.5	41.9	48.2	42.1	48.5	42.5	48.9	29.1	33.5	29.2	33.7	29.5	34.0	18.2
2.5U	12.5	72.2	75.1	72.6	75.5	73.3	76.2	50.2	52.2	50.5	52.4	50.9	52.9	32.1
2.5U	7.5	98.5	99.8	99.1	100.3	100.0	101.2	68.5	69.3	68.9	69.7	69.5	70.3	47.0
2.5U	2.5	106.3	109.7	106.9	110.3	107.9	111.3	73.9	76.2	74.3	76.6	75.0	77.3	56.8
2.5D	2.5	112.9	111.3	113.5	111.9	114.5	112.9	78.4	77.3	78.9	77.8	79.6	78.5	56.8
2.5D	7.5	103.7	101.1	104.3	101.7	105.2	102.6	72.1	70.3	72.5	70.7	73.1	71.3	47.0
2.5D	12.5	84.2	83.9	84.7	84.4	85.4	85.1	58.5	58.3	58.8	58.6	59.4	59.2	32.1
2.5D	17.5	54.4	58.6	54.7	58.9	55.2	59.4	37.8	40.7	38.0	40.9	38.4	41.3	18.2
2.5D	22.5	26.7	28.3	26.9	28.4	27.1	28.7	18.6	19.6	18.7	19.7	18.8	19.9	8.5
2.5D	27.5	9.8	11.1	9.9	11.2	10.0	11.3	6.8	7.7	6.9	7.8	6.9	7.8	3.3
7.5D	2.5	109.4	109.9	110.0	110.5	111.0	111.5	76.0	76.4	76.4	76.8	77.1	77.5	47.0
7.5D	7.5	98.7	98.4	99.3	98.9	100.2	99.8	68.6	68.4	69.0	68.8	69.6	69.4	38.9
7.5D	12.5	75.3	74.2	75.7	74.6	76.4	75.2	52.3	51.5	52.6	51.8	53.1	52.3	26.7
7.5D	17.5	45.3	46.2	45.5	46.4	45.9	46.8	31.5	32.1	31.6	32.3	31.9	32.5	15.1
7.5D	22.5	20.9	22.5	21.0	22.6	21.2	22.8	14.5	15.6	14.6	15.7	14.7	15.9	7.1
7.5D	27.5	8.0	8.3	8.1	8.3	8.1	8.4	5.6	5.8	5.6	5.8	5.7	5.8	2.8
12.5D	2.5	94.6	97.3	95.1	97.9	96.0	98.7	65.8	67.6	66.1	68.0	66.7	68.6	32.1
12.5D	7.5	76.6	80.2	77.0	80.7	77.7	81.4	53.2	55.7	53.5	56.0	54.0	56.6	26.7
12.5D	12.5	50.5	54.5	50.8	54.8	51.2	55.3	35.1	37.8	35.3	38.1	35.6	38.4	18.3
12.5D	17.5	28.0	28.5	28.2	28.7	28.4	28.9	19.5	19.8	19.6	19.9	19.8	20.1	10.5
12.5D	22.5	13.1	12.5	13.2	12.6	13.3	12.7	9.1	8.7	9.2	8.7	9.2	8.8	5.0
17.5D	2.5	72.5	75.6	72.9	76.0	73.5	76.7	50.4	52.5	50.6	52.8	51.1	53.3	18.2
17.5D	7.5	50.5	56.7	50.8	57.0	51.2	57.5	35.1	39.4	35.3	39.6	35.6	40.0	15.1
17.5D	12.5	29.5	31.4	29.6	31.5	29.9	31.8	20.5	21.8	20.6	21.9	20.8	22.1	10.5
17.5D	17.5	13.8	14.6	13.8	14.7	14.0	14.8	9.6	10.1	9.6	10.2	9.7	10.3	6.0
17.5D	22.5	6.6	7.1	6.6	7.2	6.7	7.2	4.6	4.9	4.6	5.0	4.6	5.0	2.9
22.5D	2.5	39.7	41.6	39.9	41.9	40.3	42.2	27.6	28.9	27.7	29.1	28.0	29.4	8.5
22.5D	7.5	27.3	30.1	27.5	30.2	27.7	30.5	19.0	20.9	19.1	21.0	19.3	21.2	7.1
22.5D	12.5	14.6	15.5	14.7	15.6	14.9	15.7	10.2	10.8	10.2	10.8	10.3	10.9	5.0
22.5D	17.5	7.0	7.4	7.1	7.5	7.2	7.5	4.9	5.2	4.9	5.2	5.0	5.2	2.9
27.5D	2.5	17.5	17.9	17.6	18.0	17.7	18.2	12.1	12.4	12.2	12.5	12.3	12.6	3.3
27.5D	7.5	12.4	13.7	12.5	13.7	12.6	13.9	8.6	9.5	8.7	9.5	8.7	9.6	2.8

Luminous Intensity 6.4.4.1 through 6.4.4.4

Sample	CRT1702211015-003-005				Target Input voltage		Measured Input Voltage		0, 0 Lum. Intensity		Vac Variation Factor		MMLI Factor	
Module	12" Omni Arrow				80Vac		80.1	Vac	1.004	Candela	1.004		0.722	
Color:	Red				120Vac		120.3	Vac	1.000	Candela	1.000			
Lens	Tinted				135Vac		135.1	Vac	0.999	Candela	0.999			
Photometric Test Distance: 5 meters														
Max. cd	175.2	25°C		25°C		25°C		74°C/49°C		74°C/49°C		74°C/49°C		
Vertical	Horizontal	Rated 80Vac		Measured 120Vac		Rated 135Vac		Rated 80Vac		Measured 120Vac		Rated 135Vac		Table 3
Angle	Angle	Candela	Candela	Candela	Candela	Candela	Candela	Candela	Candela	Candela	Candela	Candela	Candela	Minimum
Up/Down	Left/Right	Left	Right	Left	Right	Left	Right	Left	Right	Left	Right	Left	Right	Candela
27.5U	7.5	9.3	9.6	9.3	9.6	9.3	9.5	6.7	6.9	6.7	6.9	6.7	6.9	2.8
27.5U	2.5	11.2	11.1	11.2	11.1	11.1	11.1	8.1	8.1	8.1	8.0	8.0	8.0	3.3
22.5U	17.5	7.1	7.6	7.1	7.6	7.1	7.6	5.2	5.5	5.1	5.5	5.1	5.5	2.9
22.5U	12.5	10.8	11.0	10.7	10.9	10.7	10.9	7.8	7.9	7.8	7.9	7.7	7.9	5.0
22.5U	7.5	16.3	16.5	16.2	16.4	16.2	16.4	11.8	11.9	11.7	11.9	11.7	11.8	7.1
22.5U	2.5	21.4	21.1	21.3	21.0	21.3	20.9	15.5	15.2	15.4	15.1	15.4	15.1	8.5
17.5U	22.5	7.9	7.7	7.8	7.7	7.8	7.7	5.7	5.6	5.7	5.5	5.7	5.5	2.9
17.5U	17.5	11.9	11.9	11.8	11.8	11.8	11.8	8.6	8.6	8.5	8.5	8.5	8.5	6.0
17.5U	12.5	21.1	20.4	21.0	20.3	21.0	20.3	15.2	14.7	15.2	14.7	15.1	14.6	10.5
17.5U	7.5	35.8	33.9	35.7	33.7	35.6	33.7	25.9	24.5	25.8	24.4	25.7	24.3	15.1
17.5U	2.5	47.6	45.7	47.4	45.5	47.3	45.4	34.4	33.0	34.2	32.9	34.2	32.8	18.2
12.5U	22.5	11.6	11.4	11.6	11.4	11.6	11.3	8.4	8.2	8.4	8.2	8.4	8.2	5.0
12.5U	17.5	22.1	21.2	22.1	21.2	22.0	21.1	16.0	15.3	15.9	15.3	15.9	15.3	10.5
12.5U	12.5	41.3	40.4	41.1	40.2	41.1	40.2	29.8	29.2	29.7	29.1	29.7	29.0	18.3
12.5U	7.5	68.3	63.2	68.0	63.0	67.9	62.9	49.3	45.7	49.1	45.5	49.0	45.4	26.7
12.5U	2.5	88.2	84.8	87.8	84.4	87.7	84.3	63.7	61.2	63.4	61.0	63.3	60.9	32.1
7.5U	27.5	9.1	9.4	9.0	9.3	9.0	9.3	6.6	6.8	6.5	6.7	6.5	6.7	2.8
7.5U	22.5	18.7	19.0	18.6	18.9	18.6	18.9	13.5	13.7	13.4	13.7	13.4	13.6	7.1
7.5U	17.5	38.0	39.2	37.8	39.0	37.8	39.0	27.4	28.3	27.3	28.2	27.3	28.2	15.1
7.5U	12.5	68.8	65.5	68.5	65.2	68.4	65.1	49.7	47.3	49.5	47.1	49.4	47.0	26.7
7.5U	7.5	106.3	99.4	105.9	99.0	105.8	98.9	76.8	71.8	76.5	71.5	76.4	71.4	38.9
7.5U	2.5	129.9	126.4	129.4	125.9	129.2	125.7	93.9	91.3	93.5	90.9	93.3	90.8	47.0
2.5U	27.5	11.2	12.5	11.2	12.4	11.2	12.4	8.1	9.0	8.1	9.0	8.1	9.0	3.3
2.5U	22.5	27.2	27.8	27.0	27.6	27.0	27.6	19.6	20.0	19.5	20.0	19.5	19.9	8.5
2.5U	17.5	58.6	58.8	58.4	58.6	58.3	58.5	42.4	42.5	42.2	42.3	42.1	42.3	18.2
2.5U	12.5	98.1	92.5	97.7	92.1	97.6	92.0	70.9	66.8	70.6	66.5	70.5	66.4	32.1
2.5U	7.5	132.0	128.8	131.5	128.3	131.3	128.1	95.4	93.1	95.0	92.7	94.9	92.6	47.0
2.5U	2.5	142.9	147.4	142.3	146.8	142.1	146.6	103.2	106.5	102.8	106.0	102.7	105.9	56.8
2.5D	2.5	147.9	143.8	147.3	143.2	147.1	143.0	106.8	103.9	106.4	103.4	106.3	103.3	56.8
2.5D	7.5	139.9	130.7	139.3	130.2	139.1	130.0	101.0	94.4	100.6	94.1	100.5	93.9	47.0
2.5D	12.5	114.0	105.5	113.5	105.1	113.3	105.0	82.3	76.2	82.0	75.9	81.9	75.8	32.1
2.5D	17.5	73.8	71.2	73.5	70.9	73.4	70.8	53.3	51.4	53.1	51.2	53.0	51.1	18.2
2.5D	22.5	36.3	33.9	36.1	33.8	36.1	33.7	26.2	24.5	26.1	24.4	26.0	24.3	8.5
2.5D	27.5	12.9	13.8	12.9	13.7	12.9	13.7	9.3	10.0	9.3	9.9	9.3	9.9	3.3
7.5D	2.5	150.7	141.1	150.1	140.5	149.9	140.3	108.9	101.9	108.4	101.5	108.3	101.4	47.0
7.5D	7.5	136.7	122.9	136.1	122.4	135.9	122.2	98.7	88.8	98.3	88.4	98.2	88.3	38.9
7.5D	12.5	104.9	96.1	104.5	95.7	104.4	95.6	75.8	69.4	75.5	69.1	75.4	69.0	26.7
7.5D	17.5	58.7	60.3	58.5	60.1	58.4	60.0	42.4	43.6	42.2	43.4	42.2	43.3	15.1
7.5D	22.5	26.1	26.1	26.0	26.0	26.0	25.9	18.9	18.8	18.8	18.7	18.8	18.7	7.1
7.5D	27.5	9.2	9.7	9.2	9.7	9.2	9.7	6.7	7.0	6.6	7.0	6.6	7.0	2.8
12.5D	2.5	128.6	126.7	128.1	126.2	127.9	126.0	92.9	91.5	92.5	91.2	92.4	91.0	32.1
12.5D	7.5	103.5	101.7	103.1	101.3	103.0	101.2	74.8	73.5	74.5	73.2	74.4	73.1	26.7
12.5D	12.5	67.7	66.0	67.4	65.7	67.3	65.6	48.9	47.7	48.7	47.5	48.6	47.4	18.3
12.5D	17.5	36.7	35.6	36.5	35.5	36.5	35.4	26.5	25.7	26.4	25.6	26.4	25.6	10.5
12.5D	22.5	16.1	14.6	16.0	14.5	16.0	14.5	11.6	10.5	11.6	10.5	11.5	10.5	5.0
17.5D	2.5	94.8	96.9	94.4	96.5	94.3	96.4	68.5	70.0	68.2	69.7	68.1	69.6	18.2
17.5D	7.5	68.1	69.0	67.9	68.7	67.8	68.6	49.2	49.9	49.0	49.7	49.0	49.6	15.1
17.5D	12.5	39.6	38.6	39.4	38.5	39.4	38.4	28.6	27.9	28.5	27.8	28.4	27.8	10.5
17.5D	17.5	18.4	17.5	18.4	17.4	18.3	17.4	13.3	12.6	13.3	12.6	13.2	12.5	6.0
17.5D	22.5	7.8	8.0	7.7	8.0	7.7	8.0	5.6	5.8	5.6	5.8	5.6	5.8	2.9
22.5D	2.5	51.7	52.2	51.5	52.0	51.4	51.9	37.3	37.7	37.2	37.5	37.1	37.5	8.5
22.5D	7.5	35.6	34.4	35.4	34.3	35.4	34.2	25.7	24.9	25.6	24.8	25.6	24.7	7.1
22.5D	12.5	18.9	17.3	18.9	17.3	18.8	17.2	13.7	12.5	13.6	12.5	13.6	12.4	5.0
22.5D	17.5	8.8	8.0	8.7	7.9	8.7	7.9	6.3	5.8	6.3	5.7	6.3	5.7	2.9
27.5D	2.5	22.8	22.6	22.7	22.5	22.6	22.5	16.4	16.3	16.4	16.3	16.4	16.2	3.3
27.5D	7.5	16.1	15.5	16.0	15.4	16.0	15.4	11.6	11.2	11.6	11.1	11.6	11.1	2.8

Luminous Intensity 6.4.4.1 through 6.4.4.4

Sample	CRT1610241001-002-001			Target Input voltage		Measured Input Voltage		0, 0 Lum. Intensity		Vac Variation Factor		MMLI Factor		
Module	12" Omni Arrow			80Vac		80.3 Vac		110.1 Candela		0.984		0.707		
Color:	Red			120Vac		120.4 Vac		111.9 Candela		1.000				
Lens	Tinted			135Vac		135.2 Vac		113.2 Candela		1.012				
Photometric Test Distance: 5 meters														
Max. cd	175.2	25°C		25°C		25°C		74°C/49°C		74°C/49°C		74°C/49°C		
Vertical	Horizontal	Rated 80Vac		Measured 120Vac		Rated 135Vac		Rated 80Vac		Measured 120Vac		Rated 135Vac		Table 3
Angle	Angle	Candela	Candela	Candela	Candela	Candela	Candela	Candela	Candela	Candela	Candela	Candela	Candela	Minimum
Up/Down	Left/Right	Left	Right	Left	Right	Left	Right	Left	Right	Left	Right	Left	Right	Candela
27.5U	7.5	7.7	7.9	7.8	8.1	7.9	8.2	5.4	5.6	5.5	5.7	5.6	5.8	2.8
27.5U	2.5	9.2	9.3	9.3	9.4	9.4	9.5	6.5	6.6	6.6	6.7	6.7	6.8	3.3
22.5U	17.5	5.6	6.9	5.7	7.1	5.7	7.1	3.9	4.9	4.0	5.0	4.1	5.0	2.9
22.5U	12.5	8.6	9.5	8.7	9.7	8.8	9.8	6.1	6.7	6.2	6.8	6.3	6.9	5.0
22.5U	7.5	13.0	13.6	13.2	13.9	13.3	14.0	9.2	9.6	9.3	9.8	9.4	9.9	7.1
22.5U	2.5	16.9	17.1	17.1	17.3	17.3	17.5	11.9	12.1	12.1	12.3	12.3	12.4	8.5
17.5U	22.5	5.6	7.2	5.7	7.3	5.7	7.4	3.9	5.1	4.0	5.1	4.0	5.2	2.9
17.5U	17.5	8.6	10.4	8.8	10.5	8.9	10.7	6.1	7.3	6.2	7.5	6.3	7.5	6.0
17.5U	12.5	15.2	16.6	15.5	16.9	15.7	17.1	10.8	11.8	10.9	12.0	11.1	12.1	10.5
17.5U	7.5	26.4	27.0	26.8	27.5	27.1	27.8	18.7	19.1	19.0	19.4	19.2	19.6	15.1
17.5U	2.5	36.5	36.1	37.1	36.7	37.5	37.1	25.8	25.5	26.2	25.9	26.5	26.2	18.2
12.5U	22.5	8.1	10.3	8.2	10.5	8.3	10.6	5.7	7.3	5.8	7.4	5.9	7.5	5.0
12.5U	17.5	14.9	17.7	15.1	18.0	15.3	18.2	10.5	12.5	10.7	12.7	10.8	12.9	10.5
12.5U	12.5	28.3	32.0	28.7	32.6	29.1	32.9	20.0	22.6	20.3	23.0	20.5	23.3	18.3
12.5U	7.5	49.5	49.9	50.4	50.7	50.9	51.3	35.0	35.2	35.6	35.8	36.0	36.2	26.7
12.5U	2.5	66.5	66.1	67.6	67.2	68.4	68.0	47.0	46.7	47.8	47.5	48.4	48.0	32.1
7.5U	27.5	6.3	8.5	6.4	8.6	6.5	8.7	4.5	6.0	4.5	6.1	4.6	6.2	2.8
7.5U	22.5	12.4	16.6	12.6	16.9	12.8	17.1	8.8	11.8	8.9	11.9	9.0	12.1	7.1
7.5U	17.5	25.1	32.4	25.5	33.0	25.8	33.4	17.7	22.9	18.0	23.3	18.2	23.6	15.1
7.5U	12.5	48.6	53.8	49.4	54.7	50.0	55.3	34.4	38.1	34.9	38.7	35.3	39.1	26.7
7.5U	7.5	76.7	76.5	78.0	77.7	78.9	78.6	54.3	54.1	55.1	54.9	55.8	55.6	38.9
7.5U	2.5	92.4	90.9	93.9	92.4	95.0	93.4	65.3	64.2	66.4	65.3	67.2	66.0	47.0
2.5U	27.5	7.9	11.8	8.1	12.0	8.2	12.2	5.6	8.4	5.7	8.5	5.8	8.6	3.3
2.5U	22.5	18.9	25.8	19.2	26.2	19.4	26.5	13.4	18.2	13.6	18.5	13.7	18.8	8.5
2.5U	17.5	39.8	49.4	40.5	50.2	40.9	50.8	28.1	34.9	28.6	35.5	28.9	35.9	18.2
2.5U	12.5	70.2	74.5	71.4	75.7	72.2	76.6	49.6	52.7	50.5	53.5	51.0	54.2	32.1
2.5U	7.5	96.3	98.0	97.9	99.6	99.0	100.8	68.1	69.3	69.2	70.4	70.0	71.2	47.0
2.5U	2.5	105.1	107.4	106.8	109.2	108.0	110.5	74.3	76.0	75.5	77.2	76.4	78.1	56.8
2.5D	2.5	110.1	110.0	111.9	111.8	113.2	113.1	77.8	77.8	79.1	79.0	80.0	80.0	56.8
2.5D	7.5	99.2	98.1	100.8	99.7	102.0	100.9	70.1	69.4	71.3	70.5	72.1	71.3	47.0
2.5D	12.5	80.7	81.3	82.0	82.6	83.0	83.5	57.1	57.4	58.0	58.4	58.7	59.1	32.1
2.5D	17.5	51.7	57.0	52.6	58.0	53.2	58.6	36.6	40.3	37.2	41.0	37.6	41.4	18.2
2.5D	22.5	25.0	29.1	25.4	29.6	25.7	29.9	17.6	20.6	17.9	20.9	18.1	21.1	8.5
2.5D	27.5	9.3	12.0	9.5	12.2	9.6	12.3	6.6	8.5	6.7	8.6	6.8	8.7	3.3
7.5D	2.5	107.4	106.3	109.2	108.0	110.5	109.3	76.0	75.1	77.2	76.4	78.1	77.2	47.0
7.5D	7.5	96.8	93.1	98.4	94.6	99.6	95.7	68.5	65.8	69.6	66.9	70.4	67.6	38.9
7.5D	12.5	73.5	70.8	74.7	72.0	75.6	72.8	52.0	50.0	52.8	50.9	53.4	51.5	26.7
7.5D	17.5	42.8	45.5	43.5	46.3	44.0	46.8	30.3	32.2	30.8	32.7	31.1	33.1	15.1
7.5D	22.5	19.9	22.6	20.3	23.0	20.5	23.3	14.1	16.0	14.3	16.3	14.5	16.5	7.1
7.5D	27.5	7.7	8.6	7.8	8.7	7.9	8.8	5.5	6.1	5.5	6.2	5.6	6.3	2.8
12.5D	2.5	91.6	92.3	93.1	93.8	94.2	94.9	64.8	65.3	65.8	66.3	66.6	67.1	32.1
12.5D	7.5	73.1	77.6	74.3	78.9	75.2	79.8	51.7	54.9	52.5	55.8	53.1	56.4	26.7
12.5D	12.5	48.1	51.8	48.9	52.7	49.5	53.3	34.0	36.6	34.6	37.2	35.0	37.7	18.3
12.5D	17.5	26.7	27.6	27.1	28.1	27.4	28.4	18.9	19.5	19.2	19.8	19.4	20.1	10.5
12.5D	22.5	12.6	12.6	12.8	12.8	13.0	13.0	8.9	8.9	9.1	9.1	9.2	9.2	5.0
17.5D	2.5	68.5	71.5	69.6	72.6	70.4	73.5	48.4	50.5	49.2	51.4	49.8	52.0	18.2
17.5D	7.5	47.7	53.5	48.4	54.3	49.0	55.0	33.7	37.8	34.2	38.4	34.6	38.9	15.1
17.5D	12.5	27.6	30.9	28.1	31.4	28.4	31.8	19.5	21.8	19.9	22.2	20.1	22.5	10.5
17.5D	17.5	13.0	14.3	13.2	14.5	13.3	14.7	9.2	10.1	9.3	10.3	9.4	10.4	6.0
17.5D	22.5	6.4	7.0	6.5	7.1	6.6	7.2	4.5	5.0	4.6	5.1	4.7	5.1	2.9
22.5D	2.5	37.2	39.4	37.8	40.1	38.2	40.6	26.3	27.9	26.7	28.3	27.0	28.7	8.5
22.5D	7.5	25.8	28.1	26.3	28.5	26.6	28.9	18.3	19.8	18.6	20.2	18.8	20.4	7.1
22.5D	12.5	13.8	15.1	14.1	15.3	14.2	15.5	9.8	10.6	9.9	10.8	10.0	10.9	5.0
22.5D	17.5	6.6	7.2	6.7	7.3	6.8	7.4	4.7	5.1	4.8	5.1	4.8	5.2	2.9
27.5D	2.5	16.0	16.8	16.3	17.1	16.5	17.3	11.3	11.9	11.5	12.1	11.6	12.2	3.3
27.5D	7.5	11.4	13.0	11.6	13.2	11.8	13.3	8.1	9.2	8.2	9.3	8.3	9.4	2.8

Luminous Intensity 6.4.4.1 through 6.4.4.4

Sample	CRT1611071057-001-003				Target Input voltage		Measured Input Voltage		0, 0 Lum. Intensity		Vac Variation Factor		MMLI Factor	
Module	12" Omni Arrow				80Vac		80.2 Vac		123.0 Candela		0.993		0.686	
Color:	Red				120Vac		120.3 Vac		123.9 Candela		1.000			
Lens	Clear				135Vac		135 Vac		124.2 Candela		1.002			
Photometric Test Distance: 5 meters														
Max. cd	175.2	25°C		25°C		25°C		74°C/49°C		74°C/49°C		74°C/49°C		
Vertical	Horizontal	Rated 80Vac		Measured 120Vac		Rated 135Vac		Rated 80Vac		Measured 120Vac		Rated 135Vac		Table 3
Angle	Angle	Candela	Candela	Candela	Candela	Candela	Candela	Candela	Candela	Candela	Candela	Candela	Candela	Minimum
Up/Down	Left/Right	Left	Right	Left	Right	Left	Right	Left	Right	Left	Right	Left	Right	Candela
27.5U	7.5	7.9	8.2	8.0	8.3	8.0	8.3	5.5	5.7	5.5	5.7	5.5	5.7	2.8
27.5U	2.5	9.7	9.6	9.7	9.7	9.8	9.7	6.6	6.6	6.7	6.6	6.7	6.7	3.3
22.5U	17.5	6.0	6.4	6.0	6.5	6.0	6.5	4.1	4.4	4.1	4.4	4.1	4.5	2.9
22.5U	12.5	9.0	9.2	9.1	9.3	9.1	9.3	6.2	6.3	6.2	6.4	6.2	6.4	5.0
22.5U	7.5	13.6	14.2	13.7	14.3	13.7	14.3	9.3	9.7	9.4	9.8	9.4	9.8	7.1
22.5U	2.5	18.2	18.0	18.3	18.2	18.4	18.2	12.5	12.4	12.6	12.5	12.6	12.5	8.5
17.5U	22.5	6.4	6.6	6.4	6.6	6.4	6.6	4.4	4.5	4.4	4.5	4.4	4.6	2.9
17.5U	17.5	9.6	9.8	9.6	9.9	9.6	9.9	6.6	6.7	6.6	6.8	6.6	6.8	6.0
17.5U	12.5	16.4	16.4	16.5	16.5	16.6	16.5	11.3	11.2	11.3	11.3	11.4	11.4	10.5
17.5U	7.5	28.3	28.1	28.5	28.3	28.5	28.3	19.4	19.3	19.5	19.4	19.6	19.5	15.1
17.5U	2.5	39.5	38.7	39.8	39.0	39.9	39.1	27.1	26.6	27.3	26.8	27.4	26.8	18.2
12.5U	22.5	9.2	9.2	9.3	9.3	9.3	9.3	6.3	6.3	6.4	6.4	6.4	6.4	5.0
12.5U	17.5	16.8	17.0	16.9	17.1	16.9	17.1	11.5	11.7	11.6	11.7	11.6	11.8	10.5
12.5U	12.5	32.1	32.5	32.4	32.7	32.4	32.8	22.1	22.3	22.2	22.5	22.3	22.5	18.3
12.5U	7.5	55.1	53.5	55.5	53.9	55.6	54.0	37.8	36.7	38.1	37.0	38.2	37.1	26.7
12.5U	2.5	74.1	72.1	74.6	72.6	74.8	72.8	50.9	49.5	51.2	49.8	51.3	50.0	32.1
7.5U	27.5	7.5	7.8	7.5	7.8	7.6	7.8	5.1	5.3	5.2	5.4	5.2	5.4	2.8
7.5U	22.5	14.7	15.7	14.8	15.9	14.8	15.9	10.1	10.8	10.2	10.9	10.2	10.9	7.1
7.5U	17.5	29.4	32.4	29.7	32.6	29.7	32.7	20.2	22.2	20.4	22.4	20.4	22.4	15.1
7.5U	12.5	56.1	56.3	56.5	56.7	56.6	56.8	38.5	38.6	38.8	38.9	38.9	39.0	26.7
7.5U	7.5	88.4	85.9	89.0	86.5	89.2	86.7	60.7	59.0	61.1	59.4	61.2	59.5	38.9
7.5U	2.5	106.2	104.3	107.0	105.1	107.3	105.4	72.9	71.6	73.4	72.1	73.6	72.3	47.0
2.5U	27.5	9.4	10.6	9.4	10.7	9.5	10.7	6.4	7.3	6.5	7.3	6.5	7.4	3.3
2.5U	22.5	22.6	24.4	22.7	24.6	22.8	24.6	15.5	16.7	15.6	16.9	15.6	16.9	8.5
2.5U	17.5	47.0	50.8	47.3	51.2	47.4	51.3	32.2	34.9	32.5	35.2	32.6	35.2	18.2
2.5U	12.5	81.3	78.3	81.9	78.9	82.1	79.1	55.8	53.7	56.2	54.1	56.3	54.3	32.1
2.5U	7.5	109.1	107.2	109.9	108.0	110.2	108.3	74.9	73.6	75.4	74.1	75.6	74.3	47.0
2.5U	2.5	119.3	120.5	120.2	121.4	120.5	121.7	81.9	82.7	82.5	83.3	82.7	83.5	56.8
2.5D	2.5	123.2	124.0	124.1	124.9	124.4	125.2	84.6	85.1	85.2	85.7	85.4	85.9	56.8
2.5D	7.5	113.0	112.0	113.8	112.8	114.1	113.1	77.5	76.9	78.1	77.4	78.3	77.6	47.0
2.5D	12.5	92.0	91.0	92.6	91.7	92.9	91.9	63.1	62.5	63.6	62.9	63.7	63.1	32.1
2.5D	17.5	60.5	63.4	61.0	63.9	61.1	64.0	41.5	43.5	41.8	43.9	41.9	44.0	18.2
2.5D	22.5	29.5	29.5	29.7	29.7	29.8	29.8	20.3	20.3	20.4	20.4	20.5	20.5	8.5
2.5D	27.5	11.0	11.8	11.1	11.9	11.1	11.9	7.6	8.1	7.6	8.2	7.6	8.2	3.3
7.5D	2.5	123.3	119.7	124.2	120.6	124.5	120.9	84.6	82.2	85.3	82.8	85.5	83.0	47.0
7.5D	7.5	112.1	104.1	112.9	104.9	113.2	105.2	76.9	71.5	77.5	72.0	77.7	72.2	38.9
7.5D	12.5	84.5	79.2	85.1	79.8	85.3	80.0	58.0	54.4	58.4	54.8	58.6	54.9	26.7
7.5D	17.5	48.1	51.4	48.5	51.8	48.6	51.9	33.0	35.3	33.3	35.5	33.4	35.6	15.1
7.5D	22.5	22.8	23.6	22.9	23.8	23.0	23.8	15.6	16.2	15.7	16.3	15.8	16.3	7.1
7.5D	27.5	8.5	8.8	8.5	8.9	8.5	8.9	5.8	6.0	5.8	6.1	5.9	6.1	2.8
12.5D	2.5	104.4	107.4	105.2	108.2	105.5	108.5	71.7	73.7	72.2	74.3	72.4	74.5	32.1
12.5D	7.5	85.5	86.1	86.2	86.7	86.4	86.9	58.7	59.1	59.2	59.5	59.3	59.7	26.7
12.5D	12.5	55.7	57.1	56.1	57.5	56.2	57.6	38.2	39.2	38.5	39.5	38.6	39.6	18.3
12.5D	17.5	30.1	30.9	30.3	31.2	30.4	31.2	20.7	21.2	20.8	21.4	20.9	21.4	10.5
12.5D	22.5	13.8	13.0	14.0	13.1	14.0	13.1	9.5	8.9	9.6	9.0	9.6	9.0	5.0
17.5D	2.5	79.0	81.4	79.5	82.0	79.7	82.2	54.2	55.9	54.6	56.3	54.7	56.4	18.2
17.5D	7.5	55.4	60.3	55.8	60.7	55.9	60.9	38.0	41.4	38.3	41.7	38.4	41.8	15.1
17.5D	12.5	32.2	33.3	32.4	33.5	32.5	33.6	22.1	22.8	22.3	23.0	22.3	23.1	10.5
17.5D	17.5	14.8	15.6	14.9	15.8	15.0	15.8	10.2	10.7	10.3	10.8	10.3	10.8	6.0
17.5D	22.5	6.9	7.4	6.9	7.4	6.9	7.4	4.7	5.1	4.8	5.1	4.8	5.1	2.9
22.5D	2.5	43.6	45.4	43.9	45.7	44.0	45.8	29.9	31.1	30.1	31.4	30.2	31.4	8.5
22.5D	7.5	30.4	31.1	30.7	31.3	30.7	31.4	20.9	21.4	21.1	21.5	21.1	21.6	7.1
22.5D	12.5	16.1	15.8	16.2	16.0	16.2	16.0	11.0	10.9	11.1	10.9	11.1	11.0	5.0
22.5D	17.5	7.6	7.9	7.7	7.9	7.7	7.9	5.2	5.4	5.3	5.4	5.3	5.4	2.9
27.5D	2.5	19.2	19.6	19.4	19.8	19.4	19.8	13.2	13.5	13.3	13.6	13.3	13.6	3.3
27.5D	7.5	13.9	14.4	14.0	14.5	14.0	14.6	9.5	9.9	9.6	10.0	9.6	10.0	2.8

Luminous Intensity 6.4.4.1 through 6.4.4.4

Sample	CRT1611071057-001-004				Target Input voltage		Measured Input Voltage				0, 0 Lum. Intensity		Vac Variation Factor		MMLI Factor
Module	12" Omni Arrow				80Vac		80.1 Vac		125.2 Candela		0.987				0.670
Color:	Red				120Vac		120.3 Vac		126.9 Candela		1.000				
Lens	Clear				135Vac		135.3 Vac		127.2 Candela		1.002				
Photometric Test Distance: 5 meters															
Max. cd	175.2	25°C		25°C		25°C		74°C/49°C		74°C/49°C		74°C/49°C			
Vertical	Horizontal	Rated 80Vac		Measured 120Vac		Rated 135Vac		Rated 80Vac		Measured 120Vac		Rated 135Vac		Table 3	
Angle	Angle	Candela	Candela	Candela	Candela	Candela	Candela	Candela	Candela	Candela	Candela	Candela	Candela	Minimum	
Up/Down	Left/Right	Left	Right	Left	Right	Left	Right	Left	Right	Left	Right	Left	Right	Candela	
27.5U	7.5	8.2	8.6	8.4	8.7	8.4	8.8	5.5	5.8	5.6	5.9	5.6	5.9	2.8	
27.5U	2.5	9.9	10.0	10.0	10.2	10.1	10.2	6.6	6.7	6.7	6.8	6.7	6.8	3.3	
22.5U	17.5	6.0	7.1	6.1	7.2	6.1	7.2	4.0	4.8	4.1	4.8	4.1	4.9	2.9	
22.5U	12.5	9.0	9.8	9.2	9.9	9.2	10.0	6.1	6.6	6.1	6.7	6.2	6.7	5.0	
22.5U	7.5	13.5	14.5	13.7	14.7	13.8	14.7	9.1	9.7	9.2	9.8	9.2	9.8	7.1	
22.5U	2.5	18.1	18.4	18.4	18.6	18.4	18.7	12.2	12.3	12.3	12.5	12.4	12.5	8.5	
17.5U	22.5	6.2	7.4	6.3	7.5	6.3	7.5	4.2	4.9	4.2	5.0	4.2	5.0	2.9	
17.5U	17.5	9.4	10.5	9.5	10.7	9.5	10.7	6.3	7.0	6.4	7.1	6.4	7.2	6.0	
17.5U	12.5	16.2	17.0	16.4	17.2	16.4	17.3	10.8	11.4	11.0	11.5	11.0	11.6	10.5	
17.5U	7.5	28.4	28.3	28.8	28.6	28.8	28.7	19.0	18.9	19.3	19.2	19.3	19.2	15.1	
17.5U	2.5	39.5	39.0	40.1	39.5	40.2	39.6	26.5	26.1	26.9	26.5	26.9	26.5	18.2	
12.5U	22.5	8.9	10.3	9.1	10.4	9.1	10.5	6.0	6.9	6.1	7.0	6.1	7.0	5.0	
12.5U	17.5	16.1	17.9	16.3	18.2	16.4	18.2	10.8	12.0	10.9	12.2	11.0	12.2	10.5	
12.5U	12.5	31.2	34.3	31.6	34.8	31.7	34.8	20.9	23.0	21.2	23.3	21.2	23.4	18.3	
12.5U	7.5	55.3	54.2	56.1	55.0	56.2	55.1	37.1	36.3	37.6	36.8	37.7	36.9	26.7	
12.5U	2.5	73.6	73.9	74.6	74.9	74.8	75.1	49.4	49.6	50.0	50.2	50.1	50.3	32.1	
7.5U	27.5	7.3	8.7	7.4	8.8	7.5	8.8	4.9	5.8	5.0	5.9	5.0	5.9	2.8	
7.5U	22.5	14.2	17.1	14.4	17.4	14.4	17.4	9.5	11.5	9.6	11.6	9.7	11.7	7.1	
7.5U	17.5	28.8	34.5	29.2	35.0	29.3	35.0	19.3	23.1	19.6	23.4	19.6	23.5	15.1	
7.5U	12.5	55.1	59.0	55.8	59.8	56.0	60.0	36.9	39.6	37.4	40.1	37.5	40.2	26.7	
7.5U	7.5	88.9	86.9	90.1	88.1	90.3	88.3	59.6	58.2	60.4	59.0	60.5	59.2	38.9	
7.5U	2.5	104.6	105.0	106.0	106.4	106.3	106.7	70.1	70.4	71.0	71.3	71.2	71.5	47.0	
2.5U	27.5	9.0	11.7	9.1	11.9	9.2	11.9	6.0	7.9	6.1	8.0	6.1	8.0	3.3	
2.5U	22.5	21.6	26.0	21.9	26.4	21.9	26.5	14.5	17.5	14.7	17.7	14.7	17.7	8.5	
2.5U	17.5	45.5	53.5	46.1	54.2	46.2	54.3	30.5	35.9	30.9	36.3	31.0	36.4	18.2	
2.5U	12.5	81.0	82.5	82.1	83.7	82.3	83.9	54.3	55.3	55.0	56.1	55.2	56.2	32.1	
2.5U	7.5	110.3	110.6	111.8	112.1	112.1	112.4	73.9	74.1	74.9	75.1	75.1	75.3	47.0	
2.5U	2.5	120.9	122.9	122.5	124.6	122.8	124.9	81.0	82.4	82.1	83.5	82.3	83.7	56.8	
2.5D	2.5	127.1	125.5	128.8	127.2	129.1	127.5	85.2	84.1	86.3	85.3	86.5	85.5	56.8	
2.5D	7.5	115.3	111.8	116.9	113.3	117.2	113.6	77.3	74.9	78.4	75.9	78.5	76.1	47.0	
2.5D	12.5	92.0	92.4	93.3	93.6	93.5	93.8	61.7	61.9	62.5	62.7	62.7	62.9	32.1	
2.5D	17.5	60.3	64.4	61.1	65.3	61.2	65.4	40.4	43.1	40.9	43.7	41.0	43.8	18.2	
2.5D	22.5	29.1	30.9	29.5	31.4	29.5	31.4	19.5	20.7	19.8	21.0	19.8	21.1	8.5	
2.5D	27.5	10.6	12.5	10.8	12.7	10.8	12.7	7.1	8.4	7.2	8.5	7.2	8.5	3.3	
7.5D	2.5	123.0	122.2	124.7	123.9	125.0	124.2	82.5	81.9	83.6	83.0	83.8	83.2	47.0	
7.5D	7.5	111.3	107.3	112.8	108.8	113.1	109.1	74.6	71.9	75.6	72.9	75.8	73.1	38.9	
7.5D	12.5	83.1	81.7	84.2	82.8	84.4	83.0	55.7	54.7	56.4	55.5	56.6	55.6	26.7	
7.5D	17.5	49.3	51.4	50.0	52.1	50.1	52.2	33.0	34.4	33.5	34.9	33.6	35.0	15.1	
7.5D	22.5	22.5	24.2	22.8	24.5	22.8	24.6	15.1	16.2	15.3	16.4	15.3	16.5	7.1	
7.5D	27.5	8.3	9.0	8.4	9.2	8.4	9.2	5.5	6.1	5.6	6.1	5.6	6.2	2.8	
12.5D	2.5	105.0	106.5	106.4	107.9	106.7	108.2	70.4	71.4	71.3	72.3	71.5	72.5	32.1	
12.5D	7.5	86.0	87.8	87.2	89.0	87.4	89.2	57.7	58.9	58.4	59.7	58.6	59.8	26.7	
12.5D	12.5	56.0	58.3	56.8	59.1	56.9	59.2	37.6	39.1	38.1	39.6	38.2	39.7	18.3	
12.5D	17.5	30.0	30.4	30.4	30.9	30.4	30.9	20.1	20.4	20.3	20.7	20.4	20.7	10.5	
12.5D	22.5	13.7	13.0	13.8	13.2	13.9	13.2	9.2	8.7	9.3	8.8	9.3	8.8	5.0	
17.5D	2.5	78.6	82.2	79.6	83.3	79.8	83.5	52.7	55.1	53.4	55.8	53.5	56.0	18.2	
17.5D	7.5	54.6	60.1	55.4	60.9	55.5	61.0	36.6	40.3	37.1	40.8	37.2	40.9	15.1	
17.5D	12.5	31.1	33.3	31.5	33.7	31.6	33.8	20.8	22.3	21.1	22.6	21.2	22.7	10.5	
17.5D	17.5	14.4	14.8	14.6	15.0	14.6	15.1	9.6	9.9	9.8	10.1	9.8	10.1	6.0	
17.5D	22.5	6.7	7.2	6.8	7.3	6.8	7.4	4.5	4.8	4.5	4.9	4.5	4.9	2.9	
22.5D	2.5	43.2	45.4	43.8	46.0	43.9	46.1	28.9	30.4	29.3	30.8	29.4	30.9	8.5	
22.5D	7.5	29.7	31.2	30.1	31.6	30.2	31.7	19.9	20.9	20.2	21.2	20.2	21.2	7.1	
22.5D	12.5	15.2	15.8	15.4	16.1	15.4	16.1	10.2	10.6	10.3	10.8	10.3	10.8	5.0	
22.5D	17.5	7.2	7.5	7.2	7.6	7.3	7.6	4.8	5.0	4.9	5.1	4.9	5.1	2.9	
27.5D	2.5	18.3	19.0	18.5	19.2	18.6	19.3	12.2	12.7	12.4	12.9	12.4	12.9	3.3	
27.5D	7.5	12.9	13.9	13.1	14.1	13.1	14.1	8.7	9.3	8.8	9.4	8.8	9.5	2.8	

Luminous Intensity 6.4.4.1 through 6.4.4.4

Sample	CRT1611071057-001-005				Target Input voltage		Measured Input Voltage				0, 0 Lum. Intensity		Vac Variation Factor		MMLI Factor
Module	12" Omni Arrow				80Vac		80.4 Vac		126.4 Candela		0.982				0.686
Color:	Red				120Vac		120.1 Vac		128.7 Candela		1.000				
Lens	Clear				135Vac		135.0 Vac		126.8 Candela		0.985				
Photometric Test Distance: 5 meters															
Max. cd	175.2	25°C		25°C		25°C		74°C/49°C		74°C/49°C		74°C/49°C			
Vertical	Horizontal	Rated 80Vac		Measured 120Vac		Rated 135Vac		Rated 80Vac		Measured 120Vac		Rated 135Vac		Table 3	
Angle	Angle	Candela	Candela	Candela	Candela	Candela	Candela	Candela	Candela	Candela	Candela	Candela	Candela	Minimum	
Up/Down	Left/Right	Left	Right	Left	Right	Left	Right	Left	Right	Left	Right	Left	Right	Candela	
27.5U	7.5	8.7	9.0	8.8	9.2	8.7	9.0	5.9	6.2	6.1	6.3	6.0	6.2	2.8	
27.5U	2.5	10.4	10.4	10.6	10.6	10.5	10.4	7.2	7.1	7.3	7.3	7.2	7.2	3.3	
22.5U	17.5	6.4	7.5	6.5	7.7	6.4	7.6	4.4	5.2	4.5	5.3	4.4	5.2	2.9	
22.5U	12.5	9.6	10.5	9.8	10.7	9.6	10.5	6.6	7.2	6.7	7.3	6.6	7.2	5.0	
22.5U	7.5	14.5	15.2	14.8	15.5	14.6	15.3	10.0	10.4	10.1	10.6	10.0	10.5	7.1	
22.5U	2.5	19.0	18.9	19.3	19.3	19.0	19.0	13.0	13.0	13.3	13.2	13.1	13.0	8.5	
17.5U	22.5	6.4	7.8	6.6	8.0	6.5	7.9	4.4	5.4	4.5	5.5	4.4	5.4	2.9	
17.5U	17.5	10.0	11.3	10.2	11.5	10.1	11.3	6.9	7.8	7.0	7.9	6.9	7.8	6.0	
17.5U	12.5	17.1	18.5	17.4	18.8	17.2	18.5	11.8	12.7	12.0	12.9	11.8	12.7	10.5	
17.5U	7.5	30.4	30.9	30.9	31.5	30.5	31.0	20.8	21.2	21.2	21.6	20.9	21.3	15.1	
17.5U	2.5	42.1	41.4	42.9	42.2	42.2	41.5	28.9	28.4	29.4	28.9	29.0	28.5	18.2	
12.5U	22.5	9.5	10.9	9.7	11.1	9.6	10.9	6.5	7.5	6.7	7.6	6.6	7.5	5.0	
12.5U	17.5	16.9	18.9	17.3	19.3	17.0	19.0	11.6	13.0	11.8	13.2	11.7	13.0	10.5	
12.5U	12.5	32.8	35.2	33.4	35.8	32.9	35.3	22.5	24.1	22.9	24.6	22.6	24.2	18.3	
12.5U	7.5	57.5	56.6	58.6	57.6	57.7	56.7	39.5	38.8	40.2	39.5	39.6	38.9	26.7	
12.5U	2.5	78.4	75.2	79.8	76.6	78.7	75.4	53.8	51.6	54.8	52.5	54.0	51.8	32.1	
7.5U	27.5	7.5	9.1	7.6	9.3	7.5	9.2	5.1	6.3	5.2	6.4	5.1	6.3	2.8	
7.5U	22.5	14.7	17.6	15.0	17.9	14.7	17.6	10.1	12.1	10.3	12.3	10.1	12.1	7.1	
7.5U	17.5	29.7	35.0	30.2	35.7	29.8	35.2	20.4	24.0	20.7	24.5	20.4	24.1	15.1	
7.5U	12.5	57.5	59.7	58.6	60.8	57.7	59.9	39.5	40.9	40.2	41.7	39.6	41.1	26.7	
7.5U	7.5	92.1	87.4	93.7	89.0	92.3	87.6	63.2	59.9	64.3	61.0	63.4	60.1	38.9	
7.5U	2.5	110.0	104.0	112.0	105.9	110.3	104.3	75.5	71.3	76.8	72.6	75.7	71.6	47.0	
2.5U	27.5	9.6	12.3	9.7	12.6	9.6	12.4	6.6	8.5	6.7	8.6	6.6	8.5	3.3	
2.5U	22.5	22.9	27.3	23.3	27.8	23.0	27.4	15.7	18.8	16.0	19.1	15.8	18.8	8.5	
2.5U	17.5	48.0	54.6	48.8	55.6	48.1	54.8	32.9	37.5	33.5	38.1	33.0	37.6	18.2	
2.5U	12.5	82.4	84.7	83.9	86.2	82.6	84.9	56.5	58.1	57.5	59.1	56.7	58.3	32.1	
2.5U	7.5	111.5	112.9	113.5	115.0	111.8	113.3	76.5	77.5	77.9	78.9	76.7	77.7	47.0	
2.5U	2.5	120.8	126.0	123.0	128.3	121.2	126.4	82.9	86.4	84.4	88.0	83.1	86.7	56.8	
2.5D	2.5	127.6	128.6	129.9	130.9	128.0	129.0	87.5	88.2	89.1	89.8	87.8	88.5	56.8	
2.5D	7.5	115.8	114.3	117.9	116.4	116.2	114.7	79.4	78.4	80.9	79.9	79.7	78.7	47.0	
2.5D	12.5	96.2	94.1	97.9	95.8	96.5	94.4	66.0	64.5	67.2	65.7	66.2	64.7	32.1	
2.5D	17.5	62.9	66.5	64.0	67.7	63.1	66.7	43.1	45.6	43.9	46.4	43.3	45.7	18.2	
2.5D	22.5	30.0	32.3	30.5	32.9	30.1	32.4	20.6	22.1	20.9	22.5	20.6	22.2	8.5	
2.5D	27.5	11.1	13.0	11.3	13.2	11.1	13.0	7.6	8.9	7.7	9.1	7.6	8.9	3.3	
7.5D	2.5	126.0	120.8	128.3	123.0	126.4	121.2	86.4	82.9	88.0	84.4	86.7	83.1	47.0	
7.5D	7.5	113.5	105.8	115.6	107.7	113.9	106.1	77.9	72.6	79.3	73.9	78.1	72.8	38.9	
7.5D	12.5	85.3	80.6	86.9	82.1	85.6	80.9	58.5	55.3	59.6	56.3	58.7	55.5	26.7	
7.5D	17.5	49.7	51.7	50.6	52.6	49.9	51.9	34.1	35.5	34.7	36.1	34.2	35.6	15.1	
7.5D	22.5	23.1	25.0	23.6	25.5	23.2	25.1	15.9	17.2	16.2	17.5	15.9	17.2	7.1	
7.5D	27.5	8.6	9.5	8.8	9.6	8.6	9.5	5.9	6.5	6.0	6.6	5.9	6.5	2.8	
12.5D	2.5	105.3	107.7	107.2	109.7	105.6	108.1	72.2	73.9	73.5	75.3	72.5	74.1	32.1	
12.5D	7.5	86.7	89.7	88.3	91.4	87.0	90.0	59.5	61.6	60.6	62.7	59.7	61.8	26.7	
12.5D	12.5	57.3	59.8	58.3	60.9	57.5	60.0	39.3	41.0	40.0	41.8	39.4	41.2	18.3	
12.5D	17.5	30.1	30.8	30.6	31.4	30.1	30.9	20.6	21.1	21.0	21.5	20.7	21.2	10.5	
12.5D	22.5	14.0	13.3	14.3	13.6	14.1	13.3	9.6	9.1	9.8	9.3	9.7	9.2	5.0	
17.5D	2.5	80.6	80.4	82.1	81.9	80.9	80.7	55.3	55.2	56.3	56.2	55.5	55.3	18.2	
17.5D	7.5	55.1	59.5	56.1	60.6	55.3	59.7	37.8	40.8	38.5	41.6	37.9	41.0	15.1	
17.5D	12.5	32.0	33.4	32.6	34.1	32.1	33.5	22.0	22.9	22.4	23.4	22.0	23.0	10.5	
17.5D	17.5	14.7	15.1	15.0	15.4	14.8	15.2	10.1	10.4	10.3	10.6	10.1	10.4	6.0	
17.5D	22.5	7.1	7.5	7.2	7.7	7.1	7.6	4.8	5.2	4.9	5.3	4.9	5.2	2.9	
22.5D	2.5	42.9	43.8	43.7	44.6	43.0	44.0	29.4	30.1	30.0	30.6	29.5	30.2	8.5	
22.5D	7.5	29.7	30.9	30.3	31.5	29.8	31.0	20.4	21.2	20.8	21.6	20.5	21.3	7.1	
22.5D	12.5	15.8	15.6	16.1	15.9	15.8	15.7	10.8	10.7	11.0	10.9	10.9	10.8	5.0	
22.5D	17.5	7.4	7.6	7.6	7.7	7.5	7.6	5.1	5.2	5.2	5.3	5.1	5.2	2.9	
27.5D	2.5	18.6	18.7	18.9	19.0	18.7	18.7	12.8	12.8	13.0	13.0	12.8	12.8	3.3	
27.5D	7.5	13.3	13.6	13.5	13.9	13.3	13.7	9.1	9.4	9.3	9.5	9.1	9.4	2.8	

Complies: ☒ YES ☐ NO

Tested By:	Matthew Benninger	Signature or initials:	mb	Comp. Date:	12/16/2016,12/18/2016
Reviewed By:	cwm	Signature or initials:	<i>cwm</i>		
Test Equipment Used:	15,16,17,18				
Amb (°C):	25	RH%:	27		

Tested By:	Matthew Benninger	Signature or initials:	mb	Comp. Date:	3/10/2017
Reviewed By:	cwm	Signature or initials:	<i>cwm</i>		
Test Equipment Used:	15,16,17,18				
Amb (°C):	24	RH%:	29		

Luminance Uniformity

Luminance measurements were taken at nine locations across the signal face. A spot size of 1/2 inch was used. The luminance meter was translated from side to side and up and down remaining normal to the sample surface. The measurements were used to determine luminance uniformity. The measurements were taken after operating on the same duty cycle used during the photometric test.

Results

The ratio between the maximum and the minimum luminance was less than 10 to 1. Data follows.

12" Red Omni Arrow Tinted			
Sample	CRT1610241001-005-004	CRT1610241001-005-005	CRT1610241001-002-001
Location	Luminance	Luminance	Luminance
1	441	451	537
2	658	645	780
3	870	897	835
4	703	647	634
5	414	452	516
6	431	464	425
7	831	756	644
8	1165	944	943
9	716	713	790
Average	692	663	678
Intensity Ratio	2.8 to 1.0	2.1 to 1.0	2.2 to 1.0

12" Red Omni Arrow Clear			
Sample	CRT11071057-001-003	CRT11071057-001-004	CRT11071057-001-005
Location	Luminance	Luminance	Luminance
1	437	538	451
2	992	781	701
3	902	895	939
4	691	728	885
5	564	608	464
6	445	502	472
7	710	683	905
8	1072	1066	1365
9	725	741	665
Average	726	727	761
Intensity Ratio	2.5 to 1.0	2.1 to 1.0	3.0 to 1.0

Luminance measurements are in cd/m²

Same 60 minute warm-up used for luminous intensity

Test distance is 9.5 feet with ¼ degree aperture using the PR 740

Measured Voltage:	119.9 - 120.1	Vac
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Complies: ☒ YES ☐ NO

Tested By:	Kurt Dobler	Signature or initials:	kfd	Comp. Date:	11/17/2016
Reviewed By:	cwm	Signature or initials:	<i>cwm</i>		
Test Equipment Used:	2,3,10,11				
Amb (°C):	23.3	RH%	28		

Chromaticity 6.4.4.6

The chromaticity measurements were performed on the submitted LED Traffic Signal Modules with the spectroradiometer. The samples were operated at nominal input voltage and ambient temperature during the measurements. The measurements were taken from 380-780nm in 2nm increments.

The chromaticity measurements were taken at nine locations across the signal face. A spot size of 1/2 inch was used with the samples operating on the same duty cycle used during the photometric test. The spectroradiometer was translated from side to side and up and down remaining normal to the sample surface. The average of the measurements are recorded.

Results

12" Omni Arrow		Chromaticity Coordinates	
Color	Sample	x	y
Red (Tinted)	CRT1610241001-005-004	0.699	0.301
	CRT1610241001-005-005	0.699	0.301
	CRT1610241001-002-001	0.699	0.301

12" Omni Arrow		Chromaticity Coordinates	
Color	Sample	x	y
Red (Clear)	CRT11071057-001-003	0.697	0.302
	CRT11071057-001-004	0.697	0.302
	CRT11071057-001-005	0.697	0.303

The chromaticity measurements pass the requirements of the referenced specification.

Measured Voltage:	119.9 - 120.1	Vac
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Complies: ☒ YES ☐ NO

Tested By:	Kurt Dobler	Signature or initials:	kfd	Comp. Date	11/17/2016
Reviewed By:	cwm	Signature or initials:	<i>[Signature]</i>		
Test Equipment Used:	2,3,10,11				
Amb (°C):	23.3	RH%	28		

Color Uniformity 6.4.4.7

Three samples of each model were tested. Nine color measurements were taken at different locations on the traffic signal face. The measurements were taken after operating on the same duty cycle used during the photometric test. The dominant wave length was found using the measured (x, y) coordinates and table 3.29 of "Color Science" by Wyszecki & Stiles.

Results

12" Red Omni Arrow Tinted

Sample	CRT1610241001-005-004			CRT1610241001-005-005			CRT1610241001-002-001		
Location	x	y	Dominant	x	y	Dominant	x	y	Dominant
1	0.699	0.300	624	0.699	0.301	624	0.699	0.301	624
2	0.699	0.301	624	0.698	0.301	624	0.699	0.301	624
3	0.699	0.300	624	0.699	0.301	624	0.699	0.301	624
4	0.699	0.301	624	0.699	0.301	624	0.699	0.301	624
5	0.699	0.300	624	0.699	0.301	624	0.699	0.300	624
6	0.699	0.301	624	0.698	0.302	624	0.698	0.301	624
7	0.699	0.301	624	0.698	0.301	624	0.699	0.301	624
8	0.699	0.301	624	0.698	0.301	624	0.699	0.301	624
9	0.699	0.301	624	0.698	0.301	624	0.699	0.301	624
Average	0.699	0.301	624	0.699	0.301	624	0.699	0.301	624

12" Red Omni Arrow Clear

Sample	CRT11071057-001-003			CRT11071057-001-004			CRT11071057-001-005		
Location	x	y	Dominant	x	y	Dominant	x	y	Dominant
1	0.697	0.302	623	0.698	0.302	623	0.697	0.302	623
2	0.697	0.302	623	0.697	0.302	623	0.697	0.303	623
3	0.697	0.302	623	0.697	0.302	623	0.697	0.303	623
4	0.697	0.302	623	0.697	0.302	623	0.697	0.303	623
5	0.697	0.302	623	0.698	0.302	623	0.697	0.302	623
6	0.697	0.303	623	0.697	0.303	623	0.696	0.303	623
7	0.697	0.303	623	0.697	0.302	623	0.697	0.303	623
8	0.697	0.303	623	0.697	0.302	623	0.697	0.303	623
9	0.697	0.302	623	0.697	0.302	623	0.697	0.303	623
Average	0.697	0.302	623	0.697	0.302	623	0.697	0.303	623

Measured Voltage:	119.9 - 120.1	Vac
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Complies:	<input checked="" type="checkbox"/> YES	<input type="checkbox"/> NO
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Tested By:	Kurt Dobler/John Robins	Signature or initials:	kfd	Comp. Date:	11/17/2016
Reviewed By:	cwm	Signature or initials:	<i>cwm</i>		
Test Equipment Used:	2,3,10,11				
Amb (°C):	23.3	RH%	28		

Lens Abrasion Resistance 6.4.5.2

A lens was mounted in the abrasion test fixture with the lens facing upwards. An abrading pad was cycled back and forth (1 cycle) for twelve cycles at $10\text{cm} \pm 2\text{cm}$ per second over the test surface of the lens. The abrading pad shall not be less than $2.5\text{cm} \pm 0.1\text{cm}$ square, constructed of 0000 steel wool rubber cemented to a rigid base shaped to the contour of the lens. The "grain" of the pad was perpendicular to the direction of motion. The abrading pad support was equal in size to the pad and the center of the support surface was within $\pm 2\text{mm}$ of parallel to the lens surface. The density of the abrading pad was such that when the pad was mounted to its support and is resting unweight on the lens, the base of the pad was no closer than 3.2mm to the lens at its closest point. When mounted on its support and resting on the lens, the abrading pad was weighted such that a pad pressure of $14\text{kPa} \pm 1\text{kPa}$ exists at the center and perpendicular to the face of the lens. A pivot was used to follow the contour of the lens.

Results

A single intensity point was measured before and after the abrasion. In all samples tested the abraded lens intensity measurement was at least 90% of the un-abraded lens intensity measurement.

12" Red Omni Arrow Tinted			
Sample	Pre Abrasion	Post Abrasion	Percentage
CRT1610241001-005-005	105.4	103.8	98.5
CRT1702211015-003-005	146.2	142.9	97.7
CRT1610241001-002-001	111.9	110.5	98.7

12" Red Omni Arrow Clear			
Sample	Pre Abrasion	Post Abrasion	Percentage
CRT1611071057-001-003	123.9	119.7	96.6
CRT1611071057-001-004	126.9	124.8	98.3
CRT1611071057-001-005	128.7	125	97.1

Measured Voltage:	120.4	Vac		
Measured Weight:	11	lbs		
Abrasion Pad	5.5	Sq. In		
Pad Pressure	2.0	psi	13.8	Kpa

Complies: ☒ YES ☐ NO

Tested By:	Matthew Benninger	Signature or initials:	mb	Comp. Date	3/23/17
Reviewed By:	cwm	Signature or initials:	<i>AM</i>		
Test Equipment Used:	19,20,21,22,23				
Amb (°C):	20	RH%	31		

Current Consumption 6.4.6.1

Three samples were measured for current flow in amperes. The measured current values are supplied for comparison of Product Quality Assurance current measurements on production modules. Current measurements were taken at start up.

Results



Measurements are in (mA)

12" Red Omni Arrow			
Sample	-40°C	25°C	74°C
CRT1610241001-005-001	66.9	54.9	52.5
CRT1610241001-005-002	66.2	55.2	52.9
CRT1610241001-005-003	66.3	55.6	53.0

The current consumption was not in excess of 120% of the label current values for an ambient temperature of 25°C.

Measured Voltage:	120.1	Vac
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Complies: ☒ YES ☐ NO

Tested By:	John Robins	Signature or initials:		Comp. Date	11/10/16
Reviewed By:	cwm	Signature or initials:			
Test Equipment Used:	2,8				
Amb (°C):	na	RH%	na		

Low Voltage Turn Off 6.4.6.2

Three samples were measured to ensure compliance with the low voltage turn-off requirement. Each sample was fully illuminated at the nominal operating voltage. The applied voltage was then reduced to the point where there was no visible illumination.

Results

There was no visible illumination when the applied voltage was less than 35Vac RMS.

12" Red Omni Arrow	
Sample	Low Voltage Turn Off (Vac RMS)
CRT1610241001-005-001	64.2
CRT1610241001-005-002	64.8
CRT1610241001-005-003	65.4

Complies: ☒ YES ☐ NO

Tested By:	Kurt Dobler	Signature or initials:	kfd	Comp. Date	11/9/16
Reviewed By:	cwm	Signature or initials:	<i>cwm</i>		
Test Equipment Used:	1,9				
Amb (°f):	72	RH%	37		

Turn-On/Turn-Off Times 6.4.6.3

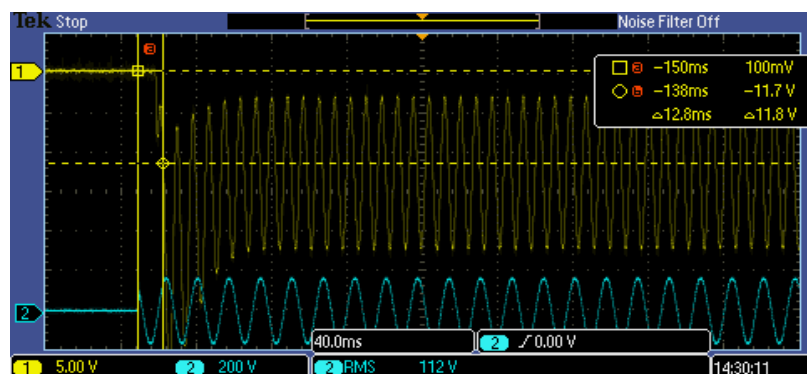
Three samples were measured to ensure compliance with the turn-on and turn-off requirements. The measurements were conducted using a two channel oscilloscope to measure the time delay between when the samples are energized at 120 Vac RMS and when the light output reaches 90% of full output. The same test equipment was used to measure the time delay between when the sample is de-energized and when the light output reaches 0% of full output.

Results

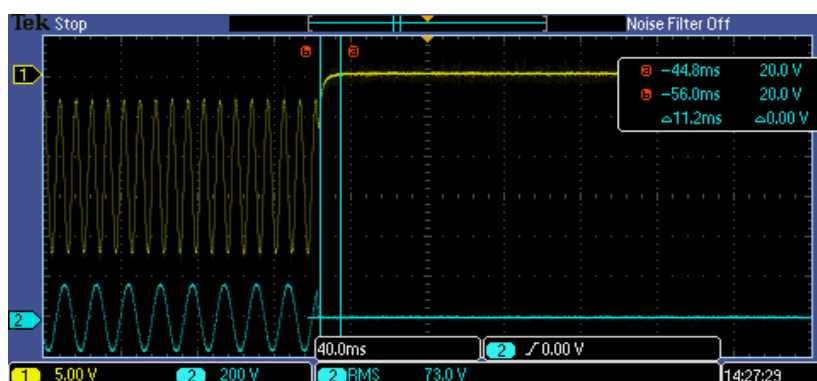
12" Red Omni Arrow		
Sample	Turn On	Turn Off
CRT1610241001-005-001	12.8	11.2
CRT1610241001-005-002	12.8	11.2
CRT1610241001-005-003	12.8	11.2

The "on" time and "off" time were within the 75ms requirement on all samples tested.

Sample Turn On Time



Sample Turn Off Time



Measured Voltage: 120 Vac

Complies: ☒ YES ☐ NO

Tested By:	John Robins	Signature or initials:	<i>JR</i>	Comp. Date	12/6/16
Reviewed By:	cwm	Signature or initials:	<i>cwm</i>		
Test Equipment Used:	9,13,14				
Amb (°f):	72	RH%	29		

Transient Voltage Immunity 6.4.6.4

Three samples were subjected to 3 positive and 3 negative 1000V 7.5 joule pulses across their input leads at a rate of 0.5 pps in accordance with NEMA TS 2-2003 section 2.1.8. The pulses were the discharge from a 15 μ F capacitor. The devices were then energized with rated voltage to verify proper operation.

Results

The signal modules withstood the applications of the transient voltage without damage or operational deterioration.

12" Red Omni Arrow			
Sample	3 Positive Pulses	3 Negative Pulses	Results
CRT1610241001-005-001	x	x	Pass
CRT1610241001-005-002	x	x	Pass
CRT1610241001-005-003	x	x	Pass

Measured Voltage:	1000	Vdc
Measured Capacitance:	15.8 - 16.6	μ F

Complies: ☒ YES ☐ NO

Tested By:	Kurt Dobler	Signature or initials:	kfd	Comp. Date	12/8/16
Reviewed By:	cwm	Signature or initials:	<i>[Signature]</i>		
Test Equipment Used:	1,9				
Amb (°f):	72	RH%	30		

Electronic Noise 6.4.6.5

Three LED traffic signal modules were operated at 120 VAC/60Hz throughout the test. Emissions measurements were taken to compare values to applicable requirements.

Results

The emissions complied with the requirements of the referenced specification. The testing was performed at our Oakdale, MN office. See report: 102785964MIN-014R

Complies: ☒ YES ☐ NO

Tested By:	Randy Libersky	Signature or initials:	See Report	Comp. Date	12/27/16
Reviewed By:	Norman Shpilsher	Signature or initials:	See Report		
Test Equipment Used:	See Report				
Amb (°C):	See Report	RH%	See Report		

Power Factor & Total Harmonic Distortion 6.4.6.6 & 6.4.6.7



Three tinted samples of each model were measured for power factor and total harmonic distortion. A commercially available power analyzer was used to perform these measurements.

Results

12" Red Omni Arrow						
Sample	Voltage	Current (mA)	Power (W)	Power Factor	THD V%	THD I%
CRT1610241001-005-001	120.1	53.7	6.2	0.97	0.82	14.4
CRT1610241001-005-002	120.1	53.9	6.3	0.97	0.81	14.2
CRT1610241001-005-003	120.1	54.0	6.3	0.97	0.80	14.4
Requirement	NA	NA	NA	≥ 0.90	≤ 20%	≤ 20%

Measurements taken after a minimum 60 minute warmup.

Complies: ☒ YES ☐ NO

Tested By:	John Robins	Signature or initials:		Comp. Date	11/9/16
Reviewed By:	cwm	Signature or initials:			
Test Equipment Used:	8,9				
Amb (°C):	74	RH%	27		

Load Switch Compatibility 6.4.7.1

Three samples were connected to a variable AC voltage supply. The sample was monitored for sufficient current draw to ensure proper load switch operation while the voltage is varied from 80V rms to 135 V rms.

Results

The load switch data is provided to the client to determine if the current draw is acceptable. The referenced ITE specification does not list a minimum current draw requirement. As a result, the Caltrans Standard Specifications dated 2010, Section 86-4.01D(2)(a) must be followed listing a minimum power consumption requirement of 5 watts for 12" traffic signal modules.

12" Red Omni Arrow		
Sample	80 Vrms	135 Vrms
CRT1610241001-005-001	75.0	56.6
CRT1610241001-005-002	75.5	56.9
CRT1610241001-005-003	75.8	52.9



Current measurements are in mA

12" Red Omni Arrow		
Sample	80 Vrms	135 Vrms
CRT1610241001-005-001	5.8	6.6
CRT1610241001-005-002	5.8	6.6
CRT1610241001-005-003	5.8	6.6

Power measurements are in watts.

Measured Voltage 80Vac:	80.1	Vac
Measured Voltage 135Vac:	134.9	Vac

Complies: ☒ YES ☐ NO

Tested By:	John Robins	Signature or initials:		Comp. Date	11/9/16
Reviewed By:	cwm	Signature or initials:			
Test Equipment Used:	8,9				
Amb (°f):	70	RH%	38		

Off State Voltage Decay 6.4.7.2

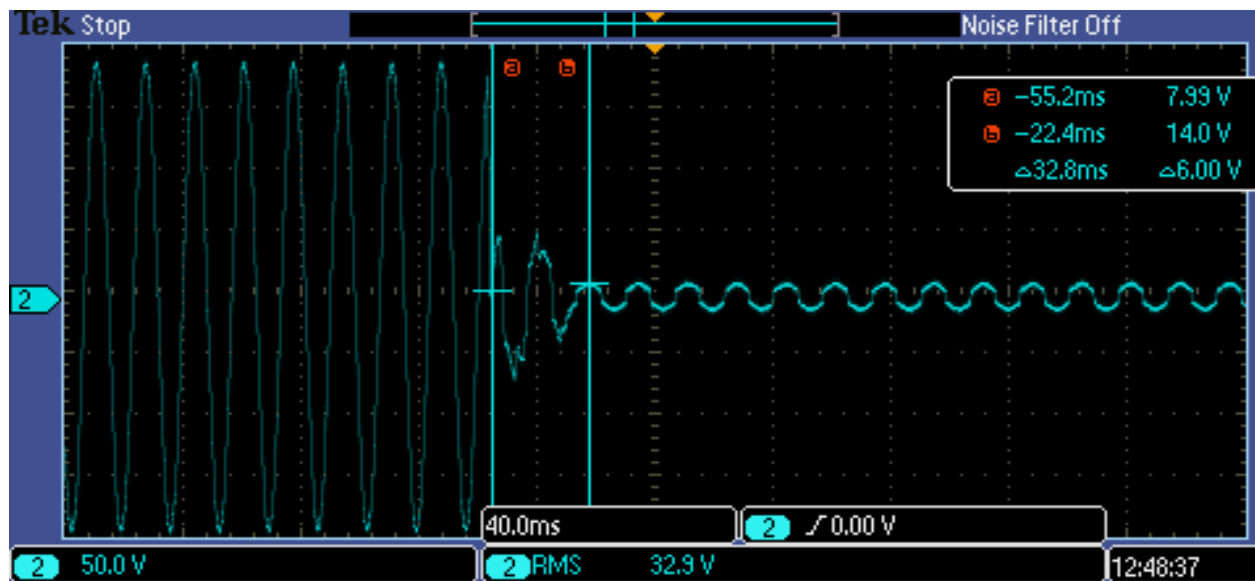
Three samples were operated from a 135V AC voltage supply. A 19.5 k-ohm resistor was wired in series in the hot line between the LED signal monitor and the AC power supply. A single-pole-single-throw switch was wired in parallel across the 19.5 k-ohm resistor. A 220 k-ohm shunt resistor was wired between the hot line connection and the neutral line connection on the LED signal module. The single-pole-single-throw switch was closed, shorting out the 19.5 k-ohm resistor, allowing the AC power supply to illuminate the LED signal module. Next the switch was opened and the voltage across the 220 k-ohm shunt resistor was measured for a decay to a value equal to or less than 10V rms within a time period equal to or less than 100 milliseconds. The test was repeated a sufficient number of times to ensure testing occurs at the peak of the AC line voltage cycle.

Results

12" Red Omni Arrow	
sample	Decay Time (mS)
CRT1610241001-005-001	31.2
CRT1610241001-005-002	32.8
CRT1610241001-005-003	32.8

In all samples measured the decay time was less than 100mS.

Sample Screen Shot



Measured Voltage: 135 Vac

Complies: ☒ YES ☐ NO

Tested By:	John Robins	Signature or initials:	<i>JR</i>	Comp. Date	12/7/16
Reviewed By:	cwm	Signature or initials:	<i>cwm</i>		
Test Equipment Used:	9,13,14				
Amb (°f):	72	RH%	29		

Failed State Impedance 6.4.8

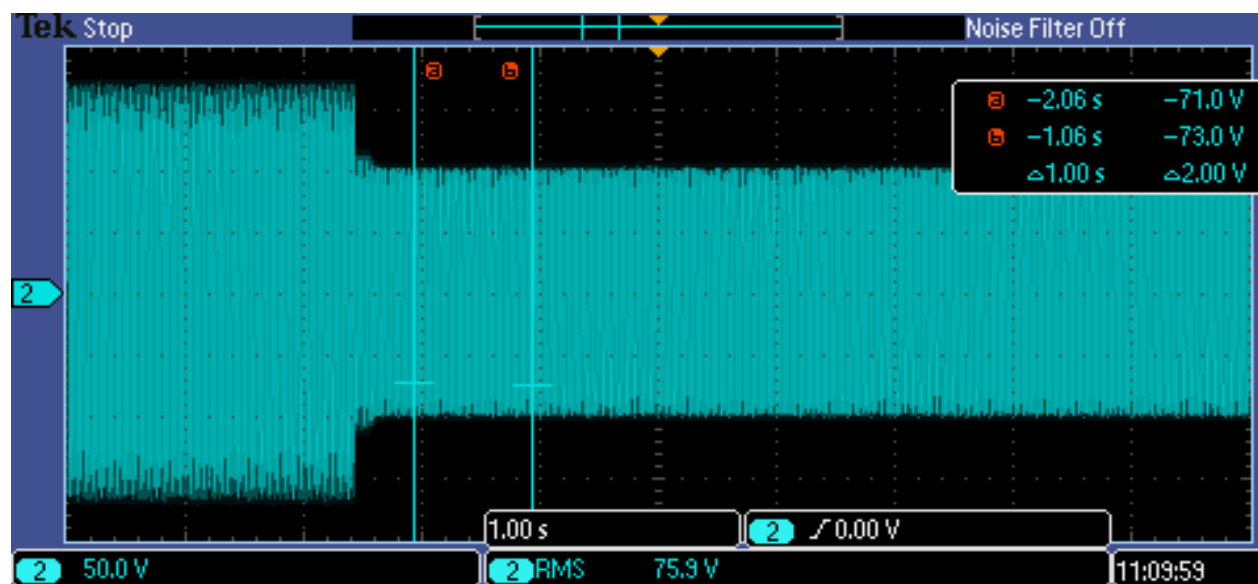
First the LED board is disconnected from the signal power supply. Then the LED signal modules are operated from a 120V AC voltage supply. A 50k-ohm resistor is wired in series in the hot line between the LED signal module and the AC power supply. A single-pole-single-throw switch is wired in parallel across the 50k-ohm resistor. A 100 k-ohm shunt resistor is wired between the hot line connection and the neutral line connection on the LED signal module. The single-pole-single-throw switch is opened and the voltage across the 100 k-ohm shunt resistor is measured from 500mS through 1500mS, after energizing the circuit with the open switch. The test was repeated 10 times.

Results

12" Red Omni Arrow	
sample	Vrms
CRT1610241001-005-001	75.8
CRT1610241001-005-002	75.9
CRT1610241001-005-003	75.9

In all samples tested the voltage across the 100KΩ resistor was greater than 70 Vac RMS.

Sample Screen Shot



Measured Voltage: 120 Vac

Complies: ☒ YES ☐ NO

Tested By:	John Robins	Signature or initials:	<i>JR</i>	Comp. Date	1/27/17
Reviewed By:	cwm	Signature or initials:	<i>cwm</i>		
Test Equipment Used:	9,13,14				
Amb (°f):	72	RH%	28		

Equipment list				
#	Intertek ID No.	Description	Manufacturer	Calibration Due
1	M207	multimeter	fluke	17-Aug-2017
2	H204	chamber	thermotron	10-Nov-2017
3	T1486	Digit Hygro-Thermometer	Extech	16-Mar-2017
4	V272	Signal Conditioner	Unholtz-Dickie	27-Jun-2017
5	V393	Vibration Controler	Unholtz-Dickie	15-Jul-2017
6	V328	Accelerometer	PCB Piezotronics	2-Dec-2016
7	V334	Accelerometer	PCB Piezotronics	18-Feb-2017
8	G032S	Power Analyzer	Yokogawa	9-May-2017
9	T835	Temp/Humidity	Supco	10-Jun-2017
10	O757	Spectra Scan	Photo Research	23-Mar-2017
11	R153	Distance Meter	Leica	7-Dec-2016
12	O719	flexOptometer	UDT	3-Dec-2016
13	V244	High Voltage Probe	Tektronix	3-Nov-2017
14	E470	Oscilloscope	Tektronix	8-Jul-2017
15	N1153	Rain Gauge	Cole-Parmer	6-Jan-2019
16	N1419	Stopwatch	Control Co	16-Aug-2017
17	T804	Thermometer	Fluke	16-May-2017
18	Y205	Anemometer	Omega	23-May-2017
19	S159	Push-Pull Scale	Controls International	13-Jan-2018
20	O109	Goniometer	Optroniks	03-Oct-2017
21	O114	5M Photometer	Optroniks	24-Oct-2017
22	T1555	Hygro-Thermometer	Extech	03-May-2017
23	M135	multimeter	Fluke	04-Apr-2017
Note: For measurement uncertainty, refer to the calibration certificates for all the test equipment located in the equipment files				



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www.intertek.com

Issue Date: February 27, 2017
Project No. G102472631
Quote No.: Qu-00673375

Contact: Hamid Kashani
Email: hamid@leotek.com
Phone No. 408-380-1788

Report No. 102472631CRT-001R

Leotek Electronics USA LLC

1955 Lundy Ave
San Jose, CA 95131

Standards

Performance Specification of the Institute of Transportation Engineers, Vehicle Traffic Control Signal Heads: Light Emitting Diode (LED) Circular Signal Supplement, dated June 27, 2005.

Standard Specifications Caltrans dated 2010. Section 86-4.01D(2)(a)

<i>Test Purpose</i>	ITE 5-Year Re-Certification Testing of Models; TSL-12R-LX-IL6-A1-P2 & TSL-12R-LX-IL6-A1-P2-CLR
<i>Test Dates</i>	November 1, 2016 through February 27, 2017

John C. Robins
Engineer
Lighting

Jeremy N. Downs, P.E.
Staff Engineer
Lighting

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Test Plan and Datasheets			
Client	Leotek Electronics USA LLC	Engineer	John C. Robins
Report #	102472631CRT-001R	Reviewer	Christopher W. Metcalf
Product	12" Red Ball Tinted & Clear	Model(s)	TSL-12R-LX-IL6-A1-P2 & P2-CLR
Standard	ITE, Circular Signal Supplement, dated June 27, 2005.		

Spec	Test name	Clause	Pass Fail NA
ITE	Conditioning	6.4.2	Pass
ITE	Mechanical Vibration	6.4.3.1	Pass
ITE	Temperature Cycling	6.4.3.2	Pass
ITE	Moisture Resistance	6.4.3.3	Pass
ITE	Luminous Intensity	6.4.4.1, 2,3,4	Pass
ITE	Luminance Uniformity	6.4.4.5	Pass
ITE	Chromaticity	6.4.4.6	Pass
ITE	Color Uniformity	6.4.4.7	Pass
ITE	Lens Abrasion Resistance	6.4.5.2	Pass
ITE	Current Consumption	6.4.6.1	Pass
ITE	Low Voltage Turn Off	6.4.6.2	Pass
ITE	Turn-On/Turn-Off Times	6.4.6.3	Pass
ITE	Transient Voltage Immunity	6.4.6.4	Pass
ITE	Electronic Noise	6.4.6.5	Pass
ITE	Power Factor & Total Harmonic Distortion	6.4.6.6, 7	Pass
ITE	Load Switch Compatibility	6.4.7.1	Pass
ITE	Off State Voltage Decay	6.4.7.2	Pass
ITE	Failed State Impedance	6.4.8	Pass

Sample Information				
Date Rec.	Package ID	Description	Condition	Model No.
10/24/2016	CRT1610241001-007	12" red tinted ball	production	TSL-12R-LX-IL6-A1-P2
10/24/2016	CRT1610241001-008	12" red tinted ball	production	TSL-12R-LX-IL6-A1-P2
11/7/2016	CRT1611071057-002	12" red ball clear	production	TSL-12R-LX-IL6-A1-P2-CLR
11/7/2016	CRT1611071057-004	12" red ball clear	production	TSL-12R-LX-IL6-A1-P2-CLR

Further Sample Description

Intertek Sample Number	Description	Model Number	Serial Number
CRT1610241001-007-001	12" red tinted ball	TSL-12R-LX-IL6-A1-P2	16917503
CRT1610241001-007-002	12" red tinted ball	TSL-12R-LX-IL6-A1-P2	16917504
CRT1610241001-007-003	12" red tinted ball	TSL-12R-LX-IL6-A1-P2	16917505
CRT1610241001-007-004	12" red tinted ball	TSL-12R-LX-IL6-A1-P2	16917506
CRT1610241001-007-005	12" red tinted ball	TSL-12R-LX-IL6-A1-P2	16917507
CRT1610241001-008-002	12" red tinted ball	TSL-12R-LX-IL6-A1-P2	16917508
CRT1611071057-002-004	12" red ball clear	TSL-12R-LX-IL6-A1-P2-CLR	T16B002
CRT1611071057-002-005	12" red ball clear	TSL-12R-LX-IL6-A1-P2-CLR	T16B001
CRT1611071057-004-004	12" red ball clear	TSL-12R-LX-IL6-A1-P2-CLR	T16B003

General Requirements

Intertek Sample Number	ETL Cert. Number	Label Identification	Lens Orientation	Color Coded Wires
CRT1610241001-007-001	7080573	Pass	Pass	Red/White
CRT1610241001-007-002	7080574	Pass	Pass	Red/White
CRT1610241001-007-003	7080575	Pass	Pass	Red/White
CRT1610241001-007-004	7080576	Pass	Pass	Red/White
CRT1610241001-007-005	7080577	Pass	Pass	Red/White
CRT1610241001-008-002	7080578	Pass	Pass	Red/White
CRT1611071057-002-004	6596121	Pass	Pass	Red/White
CRT1611071057-002-005	6596120	Pass	Pass	Red/White
CRT1611071057-004-004	6596122	Pass	Pass	Red/White

General Requirements

Intertek Sample Number	600V / 20 AWG Min.	Wire Length \geq 39"	Service Rating +105°C
CRT1610241001-007-001	600V/18AWG	Pass	Pass
CRT1610241001-007-002	600V/18AWG	Pass	Pass
CRT1610241001-007-003	600V/18AWG	Pass	Pass
CRT1610241001-007-004	600V/18AWG	Pass	Pass
CRT1610241001-007-005	600V/18AWG	Pass	Pass
CRT1610241001-008-002	600V/18AWG	Pass	Pass
CRT1611071057-002-004	600V/18AWG	Pass	Pass
CRT1611071057-002-005	600V/18AWG	Pass	Pass
CRT1611071057-004-004	600V/18AWG	Pass	Pass

Picture(s)

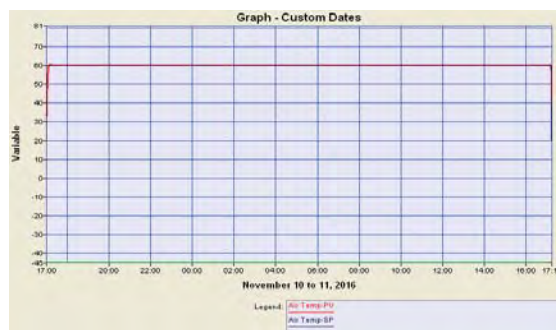
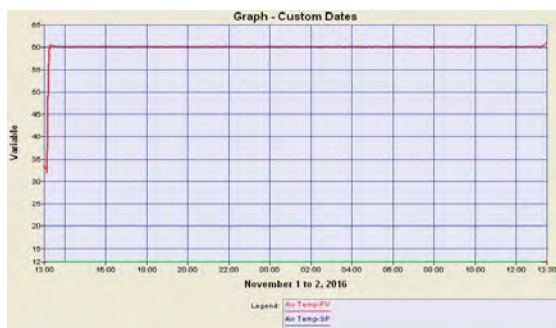


Conditioning 6.4.2

The submitted LED signal modules were subjected to conditioning prior to the environmental tests. The samples were energized for a minimum of 24 hours, at 100% duty cycle in an ambient temperature of +60°C (+140°F). At the conclusion of the test, the modules shall be visually inspected for damage and checked for proper operation.

Results

Intertek Sample Number	Description	Visual Inspection		Operational Check	
		Pre	Post	Pre	Post
CRT1610241001-007-001	12" red tinted ball	Pass	Pass	Pass	Pass
CRT1610241001-007-002	12" red tinted ball	Pass	Pass	Pass	Pass
CRT1610241001-007-003	12" red tinted ball	Pass	Pass	Pass	Pass
CRT1610241001-007-004	12" red tinted ball	Pass	Pass	Pass	Pass
CRT1610241001-007-005	12" red tinted ball	Pass	Pass	Pass	Pass
CRT1610241001-008-002	12" red tinted ball	Pass	Pass	Pass	Pass
CRT1611071057-002-004	12" red ball clear	Pass	Pass	Pass	Pass
CRT1611071057-002-005	12" red ball clear	Pass	Pass	Pass	Pass
CRT1611071057-004-004	12" red ball clear	Pass	Pass	Pass	Pass



Measured Voltage: 119.3 Vac

Complies: ☒ YES ☐ NO

Tested By:	John Robins	Signature or initials:	<i>JR</i>	Comp. Date:	10/28/16
Reviewed By:	cwm	Signature or initials:	<i>cwm</i>	Comp. Date:	11/11/16
Test Equipment Used:	1,2				
Amb (°C):	na	RH%	na		

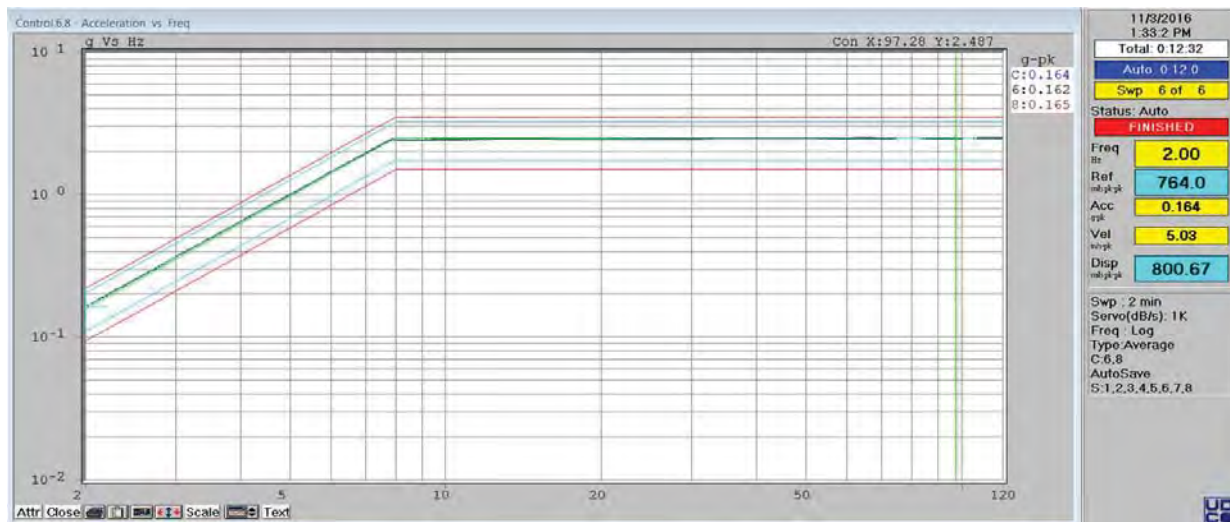
Mechanical Vibration 6.4.3.1

The submitted LED signal modules were securely mounted in traffic signal housings and vibrated along each axes for three 4 minute sweep cycles at a displacement of 0.764" from 2 to 8 Hz and 2.5 Gs from 8 to 120 Hz. Testing was conducted in accordance with MIL-STD-883, method 2007. At the conclusion of the test, the modules shall be visually inspected for damage and checked for proper operation.

Results

Intertek Sample Number	Description	x-axis lateral	y-axis horizontal	z-axis vertical	Visual Inspection	Operational Check
CRT1610241001-007-001	12" red tinted ball	X	X	X	Pass	Pass
CRT1610241001-007-002	12" red tinted ball	X	X	X	Pass	Pass
CRT1610241001-007-003	12" red tinted ball	X	X	X	Pass	Pass
CRT1610241001-007-004	12" red tinted ball	X	X	X	Pass	Pass
CRT1610241001-007-005	12" red tinted ball	X	X	X	Pass	Pass
CRT1610241001-008-002	12" red tinted ball	X	X	X	Pass	Pass

Sample Vibration Plot



Complies: ☒ YES ☐ NO

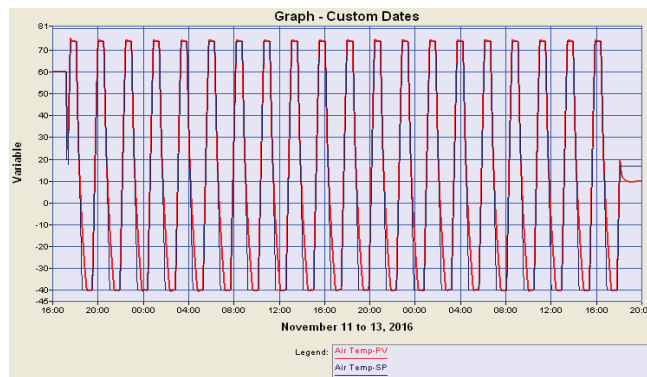
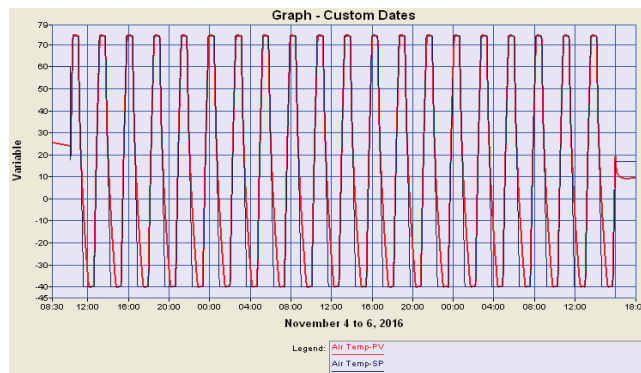
Tested By:	Gordon West	Signature or initials:	<i>Gordon West</i>	Comp. Date	11/3/16
Reviewed By:	cwm	Signature or initials:	<i>cwm</i>		
Test Equipment Used:	3,4,5,6,7				
Amb (°C):	24.1	RH%	38		

Temperature Cycling 6.4.3.2

The submitted tinted and clear LED signal modules were subjected to temperature cycling according to MIL-STD-883, Method 1010. Twenty cycles were performed with a 30 minute transfer time between temperature extremes and a 30 minute dwell time at the extremes. The temperature cycled between -40°C and +74°C. The samples were non-operating. At the conclusion of the test, the module shall be free of damage and moisture and be fully operational.

Results

Intertek Sample Number	Description	Visual Inspection	Operational Check
CRT1610241001-007-001	12" red tinted ball	Pass	Pass
CRT1610241001-007-002	12" red tinted ball	Pass	Pass
CRT1610241001-007-003	12" red tinted ball	Pass	Pass
CRT1610241001-007-004	12" red tinted ball	Pass	Pass
CRT1610241001-007-005	12" red tinted ball	Pass	Pass
CRT1610241001-008-002	12" red tinted ball	Pass	Pass
CRT1611071057-002-004	12" red ball clear	Pass	Pass
CRT1611071057-002-005	12" red ball clear	Pass	Pass
CRT1611071057-004-004	12" red ball clear	Pass	Pass



Complies: ☒ YES ☐ NO

Tested By:	John Robins	Signature or initials:		Comp. Date	11/6/16
Reviewed By:	cwm	Signature or initials:		Comp. Date	11/13/16
Test Equipment Used:	1				
Amb (°C):	na		na		

Moisture Resistance 6.4.3.3

The submitted tinted and clear LED signal modules were subjected to the rain and blowing rain test per MIL-STD-810F, Test Method 506.4, Procedure I. The test was performed on standalone modules without a protective housing. The rainfall rate was 1.7 mm/min (4in/hr) and the droplet size shall predominantly be between 0.5mm and 4.5mm (0.02 to 0.18 in). The samples were oriented such that the lens is directed towards the wind source when at a zero rotation angle. The samples were rotated at a rate of 4 degrees per minute along the vertical axis, from an orientation of -60 to +60 degrees during the test. The duration of the test is 30 minutes, and the samples were energized throughout the test. The water temperature was $25^{\circ} \pm 5^{\circ}\text{C}$ ($77^{\circ} \pm 9^{\circ}\text{F}$) and the wind velocity was 80 km/hr (50 mph). At the conclusion of the test, the module shall be free of damage and moisture and be fully operational.

Results

Intertek Sample Number	Description	Visual Inspection	Operational Check
CRT1610241001-007-001	12" red tinted ball	Pass	Pass
CRT1610241001-007-002	12" red tinted ball	Pass	Pass
CRT1610241001-007-003	12" red tinted ball	Pass	Pass
CRT1610241001-007-004	12" red tinted ball	Pass	Pass
CRT1610241001-007-005	12" red tinted ball	Pass	Pass
CRT1610241001-008-002	12" red tinted ball	Pass	Pass
CRT1611071057-002-004	12" red ball clear	Pass	Pass
CRT1611071057-002-005	12" red ball clear	Pass	Pass
CRT1611071057-004-004	12" red ball clear	Pass	Pass

Requirement: Signal Still Operational and No Moisture In The Housing

Intertek Sample Number	Sample Temp. at start (°C)	Water Temperature 25C +/- 5C			
		Start	10 minutes in.	20 minutes in.	30 minutes in.
CRT1610241001-007-001	40	25.1	21.7	24.0	25.4
CRT1610241001-007-002	40				
CRT1610241001-007-003	40	26.5	25.6	23.8	23.3
CRT1610241001-007-004	40				
CRT1610241001-007-005	40	27.8	20.2	29.2	23.5
CRT1610241001-008-002	40				
CRT1611071057-002-004	40	25.3	23.6	23.6	25.7
CRT1611071057-002-005	40				
CRT1611071057-004-004	40	24.4	24.8	24.4	24.6

Recorded rainfall rate:	4.3	in/hr
Recorded wind velocity:	48-52	mph

Complies: ☒ YES ☐ NO

Tested By:	Kurt Dobler	Signature or initials:	kfd	Comp. Date:	2/24/17
Reviewed By:	JND	Signature or initials:	JND		
Test Equipment Used:	21,22,23,24				
Amb (°C):	NA	RH%	NA		

Luminous Intensity 6.4.4.1 through 6.4.4.4

The intensity distribution tests on the submitted LED traffic signal modules were performed with the Intertek 25 meter Goniophotometer. The goniophotometer was in accordance with the goniometer described in Section 11.02 (Test Apparatus) of the Institute of Transportation Engineers' Vehicle Traffic Control Signal Heads Standard Test Method. The calibration of the goniophotometer is traceable to the National Institute of Standards and Technology. The LED modules were operated at 120 volts AC. The alignment of the LED module was performed in accordance with Section 11.03 (Alignment of Optical Unit for Test) of the Institute of Transportation Engineers' Vehicle Traffic Control Signal Heads Standard Test Method. The submitted LED signal modules were tested for maintained minimum luminous intensity at each of 78 points indicated in Table 1, of the referenced specification. These measurements were recorded at an ambient temperature of 25°C. The red LED signal modules were energized at nominal operating voltage, at a 100% duty cycle for 60 minutes.

A relative luminous intensity measurement is taken in a region from 0 to 7.5° down, and from 7.5° left to 7.5° right. The measurement is taken at 80 Vac, 120 Vac and 135 Vac. When the 80 Vac and 135 Vac factors are applied to the photometric data the units shall still meet the photometric requirements of each model.

A diminution factor was measured by using the submitted samples. The modules were mounted in a dual compartment temperature chamber with the lensed portion in one compartment and all portions behind the lens within the other compartment. At room ambient temperature (both inside and outside the chamber) and in calm air outside the chamber, the modules were energized per the conditions described above and a single on-axis reading (IA) taken and recorded. With the modules off, the chamber was heated to 74°C behind the lens and 49°C in front of the lens, and allowed to stabilize. Following stabilization, the modules were energized per the above cycle and the single on-axis reading (IH) taken and recorded. A diminution factor was calculated (IH/IA). The readings recorded initially were factored by the diminution factor.

Luminous Intensity 6.4.4.1 through 6.4.4.4

Sample	CRT1610241001-007-004				Target Input voltage		Measured Input Voltage		H, V Lum. Intensity		Vac Variation Factor		MMLI Factor	
Module	12" Ball				80Vac		80.3 Vac		766.0 Candela		0.997		0.703	
Color:	Red				120Vac		120.3 Vac		768.1 Candela		1.000			
Lens	Tinted				135Vac		135.5 Vac		766.8 Candela		0.998			
Photometric Test Distance: 25 meters														
Max	1095	25°C		25°C		25°C		74°C/49°C		74°C/49°C		74°C/49°C		
Vertical	Horizontal	Rated 80Vac		Measured 120Vac		Rated 135Vac		Rated 80Vac		Measured 120Vac		Rated 135Vac		Table 1
Angle	Angle	Candela	Candela	Candela	Candela	Candela	Candela	Candela	Candela	Candela	Candela	Candela	Candela	Minimum
Up/Down	Left/Right	Left	Right	Left	Right	Left	Right	Left	Right	Left	Right	Left	Right	Candela
12.5U	2.5	103	105	104	105	104	105	73	74	73	74	73	74	37
12.5U	7.5	82	85	83	85	82	85	58	60	58	60	58	60	29
7.5U	2.5	175	183	175	184	175	183	123	129	123	129	123	129	69
7.5U	7.5	132	149	133	150	132	150	93	105	93	105	93	105	55
7.5U	12.5	88	110	88	110	88	110	62	77	62	77	62	77	40
2.5U	2.5	449	477	450	478	449	477	315	335	316	336	316	335	150
2.5U	7.5	307	383	308	384	308	384	216	269	216	270	216	270	124
2.5U	12.5	186	267	187	268	186	268	131	188	131	188	131	188	84
2.5U	17.5	106	174	106	174	106	174	74	122	74	122	74	122	47
2.5U	22.5	63	113	63	114	63	114	44	80	44	80	44	80	26
2.5D	2.5	1011	1019	1014	1022	1012	1020	711	716	713	718	711	717	358
2.5D	7.5	752	840	754	842	753	841	529	590	530	592	529	591	292
2.5D	12.5	469	582	470	584	469	583	329	409	330	410	330	409	201
2.5D	17.5	255	354	256	355	255	354	179	249	180	249	179	249	117
2.5D	22.5	145	207	146	207	146	207	102	145	102	146	102	145	62
2.5D	27.5	85	120	85	120	85	120	59	84	60	84	59	84	33
7.5D	2.5	920	878	923	881	921	879	647	617	648	619	647	618	281
7.5D	7.5	733	703	735	705	734	704	515	494	517	496	516	495	234
7.5D	12.5	509	445	510	446	509	446	357	313	358	314	358	313	157
7.5D	17.5	301	267	302	268	302	268	212	188	212	188	212	188	91
7.5D	22.5	178	141	178	141	178	141	125	99	125	99	125	99	47
7.5D	27.5	109	80	110	80	109	80	77	56	77	56	77	56	26
12.5D	2.5	347	338	348	339	348	338	244	238	245	238	244	238	110
12.5D	7.5	276	277	276	278	276	278	194	195	194	195	194	195	88
12.5D	12.5	188	180	189	180	188	180	132	126	133	127	132	126	62
12.5D	17.5	120	115	120	115	120	115	84	81	84	81	84	81	37
12.5D	22.5	74	71	74	72	74	71	52	50	52	50	52	50	18
12.5D	27.5	50	47	50	47	50	47	35	33	35	33	35	33	11
17.5D	2.5	198	200	199	200	198	200	139	140	140	141	139	140	51
17.5D	7.5	153	173	153	174	153	174	107	122	108	122	107	122	40
17.5D	12.5	105	120	105	120	105	120	74	84	74	85	74	84	29
17.5D	17.5	66	81	66	81	66	81	46	57	46	57	46	57	15
17.5D	22.5	45	54	45	54	45	54	32	38	32	38	32	38	7
22.5D	2.5	134	137	135	137	134	137	94	96	95	96	94	96	37
22.5D	7.5	104	122	105	122	105	122	73	85	74	86	73	86	29
22.5D	12.5	74	86	74	86	74	86	52	60	52	60	52	60	22
22.5D	17.5	50	61	50	61	50	61	35	43	35	43	35	43	11
27.5D	2.5	88	87	88	87	88	87	62	61	62	61	62	61	26
27.5D	7.5	69	79	70	79	70	79	49	56	49	56	49	56	18

Luminous Intensity 6.4.4.1 through 6.4.4.4

Sample:	CRT1610241001-007-005			Target Input voltage		Measured Input Voltage		H, V Lum. Intensity		Vac Variation Factor		MMLI Factor		
Module	12" Ball			80Vac		80.0 Vac		853.1 Candela		0.998		0.702		
Color:	Red			120Vac		120.2 Vac		854.7 Candela		1.000				
Lens	Tinted			135Vac		135.3 Vac		854.1 Candela		0.999				
Photometric Test Distance: 25 meters														
Max	1095	25°C		25°C		25°C		74°C/49°C		74°C/49°C		74°C/49°C		
Vertical	Horizontal	Rated 80Vac		Measured 120Vac		Rated 135Vac		Rated 80Vac		Measured 120Vac		Rated 135Vac		Table 1
Angle	Angle	Candela	Candela	Candela	Candela	Candela	Candela	Candela	Candela	Candela	Candela	Candela	Candela	Minimum
Up/Down	Left/Right	Left	Right	Left	Right	Left	Right	Left	Right	Left	Right	Left	Right	Candela
12.5U	2.5	107	107	107	108	107	108	75	75	75	76	75	76	37
12.5U	7.5	86	89	86	89	86	89	60	62	60	62	60	62	29
7.5U	2.5	189	200	189	200	189	200	132	140	133	140	133	140	69
7.5U	7.5	142	168	142	168	142	168	100	118	100	118	100	118	55
7.5U	12.5	94	125	94	125	94	125	66	87	66	88	66	88	40
2.5U	2.5	513	560	514	562	513	561	360	394	361	394	361	394	150
2.5U	7.5	349	463	350	464	350	463	245	325	246	326	246	325	124
2.5U	12.5	211	326	211	327	211	326	148	229	148	229	148	229	84
2.5U	17.5	116	213	117	213	117	213	82	149	82	150	82	150	47
2.5U	22.5	70	141	70	141	70	141	49	99	49	99	49	99	26
2.5D	2.5	1032	1053	1034	1055	1033	1054	725	739	726	741	726	740	358
2.5D	7.5	785	832	786	834	786	833	551	585	552	586	552	585	292
2.5D	12.5	494	552	495	553	494	553	347	388	347	389	347	388	201
2.5D	17.5	266	324	266	324	266	324	187	227	187	228	187	227	117
2.5D	22.5	152	189	152	189	152	189	107	133	107	133	107	133	62
2.5D	27.5	89	110	89	110	89	110	63	77	63	77	63	77	33
7.5D	2.5	654	599	655	601	655	600	459	421	460	422	460	421	281
7.5D	7.5	548	472	549	473	548	472	385	331	385	332	385	332	234
7.5D	12.5	393	295	393	295	393	295	276	207	276	207	276	207	157
7.5D	17.5	239	186	240	186	240	186	168	130	168	131	168	130	91
7.5D	22.5	149	105	149	105	149	105	104	74	105	74	104	74	47
7.5D	27.5	97	63	97	64	97	64	68	45	68	45	68	45	26
12.5D	2.5	262	257	262	257	262	257	184	180	184	181	184	180	110
12.5D	7.5	209	216	209	217	209	217	146	152	147	152	147	152	88
12.5D	12.5	148	147	148	147	148	147	104	103	104	103	104	103	62
12.5D	17.5	97	97	98	97	98	97	68	68	69	68	69	68	37
12.5D	22.5	65	64	65	64	65	64	46	45	46	45	46	45	18
12.5D	27.5	47	44	47	44	47	44	33	31	33	31	33	31	11
17.5D	2.5	163	165	163	166	163	165	114	116	115	116	115	116	51
17.5D	7.5	127	146	127	147	127	146	89	103	89	103	89	103	40
17.5D	12.5	91	103	91	104	91	104	64	73	64	73	64	73	29
17.5D	17.5	60	73	60	73	60	73	42	51	42	51	42	51	15
17.5D	22.5	44	50	44	50	44	50	31	35	31	35	31	35	7
22.5D	2.5	112	113	112	113	112	113	79	79	79	79	79	79	37
22.5D	7.5	88	103	88	103	88	103	62	72	62	72	62	72	29
22.5D	12.5	65	74	66	74	66	74	46	52	46	52	46	52	22
22.5D	17.5	47	55	47	55	47	55	33	39	33	39	33	39	11
27.5D	2.5	74	72	74	73	74	73	52	51	52	51	52	51	26
27.5D	7.5	60	67	60	67	60	67	42	47	42	47	42	47	18

Luminous Intensity 6.4.4.1 through 6.4.4.4

Sample:	CRT1610241001-008-002				Target Input voltage		Measured Input Voltage		H, V Lum. Intensity		Vac Variation Factor		MMLI Factor	
Module	12" Ball				80Vac		80.4 Vac		762.4 Candela		0.993		0.705	
Color:	Red				120Vac		120.1 Vac		768.1 Candela		1.000			
Lens	Tinted				135Vac		135.1 Vac		769.0 Candela		1.001			
Photometric Test Distance: 25 meters														
Max	1095	25°C		25°C		25°C		74°C/49°C		74°C/49°C		74°C/49°C		
Vertical	Horizontal	Rated 80Vac		Measured 120Vac		Rated 135Vac		Rated 80Vac		Measured 120Vac		Rated 135Vac		Table 1
Angle	Angle	Candela	Candela	Candela	Candela	Candela	Candela	Candela	Candela	Candela	Candela	Candela	Candela	Minimum
Up/Down	Left/Right	Left	Right	Left	Right	Left	Right	Left	Right	Left	Right	Left	Right	Candela
12.5U	2.5	106	105	107	106	107	106	74	74	75	74	75	75	37
12.5U	7.5	86	84	87	84	87	84	61	59	61	59	61	60	29
7.5U	2.5	184	180	185	182	186	182	130	127	131	128	131	128	69
7.5U	7.5	147	141	148	142	149	142	104	99	105	100	105	100	55
7.5U	12.5	104	98	105	98	105	98	73	69	74	69	74	69	40
2.5U	2.5	484	479	488	483	488	483	341	337	344	340	344	340	150
2.5U	7.5	366	357	369	360	369	361	258	252	260	254	260	254	124
2.5U	12.5	239	228	241	230	241	230	168	161	170	162	170	162	84
2.5U	17.5	149	136	150	137	150	137	105	96	106	97	106	97	47
2.5U	22.5	94	83	95	84	95	84	66	59	67	59	67	59	26
2.5D	2.5	1002	1006	1009	1014	1010	1015	706	709	711	714	712	715	358
2.5D	7.5	786	798	791	804	792	805	553	562	558	566	558	567	292
2.5D	12.5	521	525	525	529	525	529	367	370	370	373	370	373	201
2.5D	17.5	311	299	313	301	313	302	219	211	221	212	221	213	117
2.5D	22.5	183	179	185	181	185	181	129	126	130	127	130	128	62
2.5D	27.5	103	109	104	110	104	110	72	77	73	77	73	77	33
7.5D	2.5	858	859	865	866	866	867	605	606	609	610	610	611	281
7.5D	7.5	678	692	683	697	684	698	478	488	481	491	482	492	234
7.5D	12.5	463	467	466	470	467	471	326	329	328	331	329	332	157
7.5D	17.5	282	269	284	271	284	271	199	189	200	191	200	191	91
7.5D	22.5	161	153	162	154	162	154	113	108	114	109	114	109	47
7.5D	27.5	94	93	95	93	95	93	66	65	67	66	67	66	26
12.5D	2.5	336	334	338	337	339	337	237	236	238	237	239	238	110
12.5D	7.5	274	266	276	268	276	268	193	188	194	189	195	189	88
12.5D	12.5	187	171	188	172	189	172	132	120	133	121	133	121	62
12.5D	17.5	121	105	122	106	122	106	86	74	86	75	86	75	37
12.5D	22.5	75	65	75	65	75	65	53	46	53	46	53	46	18
12.5D	27.5	48	44	48	45	48	45	34	31	34	31	34	31	11
17.5D	2.5	197	194	199	196	199	196	139	137	140	138	140	138	51
17.5D	7.5	164	157	165	158	166	158	116	111	117	111	117	112	40
17.5D	12.5	115	107	116	108	116	108	81	75	81	76	81	76	29
17.5D	17.5	77	69	77	69	77	69	54	48	54	49	54	49	15
17.5D	22.5	52	47	52	48	53	48	37	33	37	34	37	34	7
22.5D	2.5	133	134	134	135	134	135	94	94	95	95	95	95	37
22.5D	7.5	112	111	113	112	113	112	79	79	80	79	80	79	29
22.5D	12.5	81	79	81	80	81	80	57	56	57	56	57	56	22
22.5D	17.5	56	55	56	55	56	55	39	39	40	39	40	39	11
27.5D	2.5	86	87	86	88	86	88	60	61	61	62	61	62	26
27.5D	7.5	73	75	73	75	74	75	51	53	52	53	52	53	18

Luminous Intensity 6.4.4.1 through 6.4.4.4

Sample:	CRT1611071057-002-004			Target Input voltage		Measured Input Voltage		H, V Lum. Intensity		Vac Variation Factor		MMLI Factor		
Module	12" Ball			80Vac		80.2 Vac		845.1 Candela		0.994		0.701		
Color:	Red			120Vac		120.0 Vac		850.5 Candela		1.000				
Lens	Clear			135Vac		135.5 Vac		843.0 Candela		0.991				
Photometric Test Distance: 25 meters														
Max	1095	25°C		25°C		25°C		74°C/49°C		74°C/49°C		74°C/49°C		
Vertical	Horizontal	Rated 80Vac		Measured 120Vac		Rated 135Vac		Rated 80Vac		Measured 120Vac		Rated 135Vac		Table 1
Angle	Angle	Candela	Candela	Candela	Candela	Candela	Candela	Candela	Candela	Candela	Candela	Candela	Candela	Minimum
Up/Down	Left/Right	Left	Right	Left	Right	Left	Right	Left	Right	Left	Right	Left	Right	Candela
12.5U	2.5	114	116	115	117	114	116	80	81	81	82	80	81	37
12.5U	7.5	91	95	91	96	90	95	64	67	64	67	63	67	29
7.5U	2.5	208	218	210	219	208	217	146	153	147	154	146	152	69
7.5U	7.5	158	177	159	179	157	177	111	124	111	125	110	124	55
7.5U	12.5	105	127	105	128	104	127	73	89	74	90	73	89	40
2.5U	2.5	545	569	548	573	543	567	382	399	384	402	381	398	150
2.5U	7.5	395	454	398	457	394	453	277	318	279	320	276	318	124
2.5U	12.5	243	300	244	302	242	299	170	210	171	212	170	210	84
2.5U	17.5	138	188	139	190	138	188	97	132	98	133	97	132	47
2.5U	22.5	82	118	83	119	82	118	58	83	58	83	57	83	26
2.5D	2.5	1037	1043	1044	1050	1035	1041	728	732	732	736	726	730	358
2.5D	7.5	813	821	818	826	811	819	570	576	574	579	569	574	292
2.5D	12.5	528	555	531	559	526	554	370	389	372	392	369	388	201
2.5D	17.5	295	338	297	341	294	338	207	237	208	239	206	237	117
2.5D	22.5	176	197	177	198	175	196	123	138	124	139	123	138	62
2.5D	27.5	104	111	104	112	103	111	73	78	73	79	73	78	33
7.5D	2.5	791	784	796	789	789	782	555	550	558	553	553	549	281
7.5D	7.5	645	617	649	621	643	616	452	433	455	436	451	432	234
7.5D	12.5	453	407	455	409	451	406	317	285	319	287	317	284	157
7.5D	17.5	267	257	269	259	266	257	187	180	188	182	187	180	91
7.5D	22.5	152	143	153	144	152	143	107	100	107	101	106	100	47
7.5D	27.5	92	83	92	83	91	82	64	58	65	58	64	58	26
12.5D	2.5	348	348	351	350	347	347	244	244	246	245	244	243	110
12.5D	7.5	276	283	278	285	275	282	194	199	195	200	193	198	88
12.5D	12.5	181	188	182	189	180	187	127	132	128	132	126	131	62
12.5D	17.5	111	120	112	121	111	120	78	84	78	85	78	84	37
12.5D	22.5	66	74	67	74	66	73	47	52	47	52	47	51	18
12.5D	27.5	44	47	45	47	44	47	31	33	31	33	31	33	11
17.5D	2.5	206	207	208	208	206	206	145	145	146	146	144	145	51
17.5D	7.5	163	176	164	177	162	175	114	123	115	124	114	123	40
17.5D	12.5	110	122	111	123	110	122	77	86	78	86	77	85	29
17.5D	17.5	70	81	70	81	69	81	49	57	49	57	49	57	15
17.5D	22.5	47	54	47	54	47	54	33	38	33	38	33	38	7
22.5D	2.5	137	139	138	139	136	138	96	97	96	98	96	97	37
22.5D	7.5	112	118	112	119	111	118	78	83	79	83	78	83	29
22.5D	12.5	79	85	80	86	79	85	56	60	56	60	56	60	22
22.5D	17.5	53	59	54	60	53	59	38	42	38	42	37	42	11
27.5D	2.5	88	89	89	89	88	89	62	62	62	63	62	62	26
27.5D	7.5	74	78	75	78	74	78	52	54	52	55	52	54	18

Luminous Intensity 6.4.4.1 through 6.4.4.4

Sample:	CRT1611071057-002-005			Target Input voltage		Measured Input Voltage		H, V Lum. Intensity		Vac Variation Factor		MMLI Factor		
Module	12" Ball			80Vac		80.3 Vac		864.1 Candela		0.993		0.705		
Color:	Red			120Vac		120.5 Vac		870.5 Candela		1.000				
Lens	Clear			135Vac		135.5 Vac		868.0 Candela		0.997				
Photometric Test Distance: 25 meters														
Max	1095	25°C		25°C		25°C		74°C/49°C		74°C/49°C		74°C/49°C		
Vertical	Horizontal	Rated 80Vac		Measured 120Vac		Rated 135Vac		Rated 80Vac		Measured 120Vac		Rated 135Vac		Table 1
Angle	Angle	Candela	Candela	Candela	Candela	Candela	Candela	Candela	Candela	Candela	Candela	Candela	Candela	Minimum
Up/Down	Left/Right	Left	Right	Left	Right	Left	Right	Left	Right	Left	Right	Left	Right	Candela
12.5U	2.5	113	116	114	117	114	116	80	82	81	82	80	82	37
12.5U	7.5	90	95	91	95	90	95	63	67	64	67	64	67	29
7.5U	2.5	203	216	204	218	203	217	143	152	144	154	143	153	69
7.5U	7.5	150	180	151	182	151	181	106	127	107	128	106	128	55
7.5U	12.5	97	133	97	134	97	133	68	94	69	94	68	94	40
2.5U	2.5	518	561	522	565	520	563	365	395	368	398	367	397	150
2.5U	7.5	356	471	359	474	358	473	251	332	253	334	252	333	124
2.5U	12.5	213	332	214	335	214	334	150	234	151	236	151	235	84
2.5U	17.5	117	216	117	217	117	217	82	152	83	153	83	153	47
2.5U	22.5	67	137	67	138	67	138	47	97	48	97	47	97	26
2.5D	2.5	1046	1072	1054	1080	1051	1077	738	756	743	762	741	759	358
2.5D	7.5	804	891	810	897	808	895	567	628	571	633	570	631	292
2.5D	12.5	494	622	498	627	497	625	349	439	351	442	350	441	201
2.5D	17.5	262	371	264	374	263	373	185	262	186	264	186	263	117
2.5D	22.5	148	216	149	217	149	216	105	152	105	153	105	153	62
2.5D	27.5	88	122	88	123	88	123	62	86	62	87	62	87	33
7.5D	2.5	912	843	918	849	916	847	643	595	648	599	646	597	281
7.5D	7.5	730	687	736	692	733	690	515	484	519	488	517	486	234
7.5D	12.5	508	418	512	421	510	420	358	295	361	297	360	296	157
7.5D	17.5	302	260	305	262	304	261	213	183	215	185	214	184	91
7.5D	22.5	180	136	181	137	181	137	127	96	128	97	127	97	47
7.5D	27.5	111	75	112	76	112	76	78	53	79	54	79	53	26
12.5D	2.5	374	370	376	373	375	372	264	261	265	263	265	262	110
12.5D	7.5	293	304	295	306	294	305	207	214	208	216	208	215	88
12.5D	12.5	202	197	204	199	203	198	143	139	144	140	143	140	62
12.5D	17.5	128	125	129	126	129	126	90	88	91	89	91	89	37
12.5D	22.5	78	74	79	75	79	75	55	52	56	53	55	53	18
12.5D	27.5	53	47	54	47	53	47	38	33	38	33	38	33	11
17.5D	2.5	214	220	216	222	215	221	151	155	152	156	152	156	51
17.5D	7.5	164	191	165	192	165	192	116	135	117	136	116	135	40
17.5D	12.5	112	132	113	133	112	133	79	93	80	94	79	93	29
17.5D	17.5	70	88	70	88	70	88	49	62	50	62	49	62	15
17.5D	22.5	48	57	48	57	48	57	34	40	34	40	34	40	7
22.5D	2.5	144	147	145	148	145	147	102	103	103	104	102	104	37
22.5D	7.5	111	130	112	131	111	130	78	92	79	92	78	92	29
22.5D	12.5	78	92	79	93	79	93	55	65	56	66	56	66	22
22.5D	17.5	53	64	53	65	53	64	37	45	38	46	37	45	11
27.5D	2.5	94	93	94	94	94	94	66	66	67	66	66	66	26
27.5D	7.5	74	86	75	86	74	86	52	60	53	61	52	61	18

Luminous Intensity 6.4.4.1 through 6.4.4.4

Sample:	CRT1611071057-004-004				Target Input voltage		Measured Input Voltage				H, V Lum. Intensity		Vac Variation Factor		MMLI Factor
Module	12" Ball				80Vac		80.3 Vac		824.5 Candela		0.994				0.714
Color:	Red				120Vac		120.2 Vac		829.4 Candela		1.000				
Lens	Clear				135Vac		135.2 Vac		832 Candela		1.003				
Photometric Test Distance: 25 meters															
Max	1095	25°C		25°C		25°C		74°C/49°C		74°C/49°C		74°C/49°C			
Vertical	Horizontal	Rated 80Vac		Measured 120Vac		Rated 135Vac		Rated 80Vac		Measured 120Vac		Rated 135Vac		Table 1	
Angle	Angle	Candela	Candela	Candela	Candela	Candela	Candela	Candela	Candela	Candela	Candela	Candela	Candela	Minimum	
Up/Down	Left/Right	Left	Right	Left	Right	Left	Right	Left	Right	Left	Right	Left	Right	Candela	
12.5U	2.5	109	111	110	111	110	112	78	79	79	79	79	80	37	
12.5U	7.5	87	90	88	90	88	91	62	64	63	64	63	65	29	
7.5U	2.5	192	197	193	198	194	199	137	140	138	141	138	142	69	
7.5U	7.5	147	161	148	162	148	162	105	115	106	115	106	116	55	
7.5U	12.5	99	114	100	115	100	115	71	81	71	82	71	82	40	
2.5U	2.5	519	535	522	538	523	540	370	382	372	384	374	385	150	
2.5U	7.5	379	417	381	419	382	420	270	297	272	299	273	300	124	
2.5U	12.5	234	274	235	275	236	276	167	195	168	197	168	197	84	
2.5U	17.5	136	171	137	172	137	172	97	122	98	122	98	123	47	
2.5U	22.5	80	106	81	107	81	107	57	76	58	76	58	77	26	
2.5D	2.5	1057	1050	1063	1056	1066	1059	754	749	759	754	761	756	358	
2.5D	7.5	833	838	838	843	840	846	595	598	598	602	600	604	292	
2.5D	12.5	535	563	538	566	540	568	382	402	384	404	385	405	201	
2.5D	17.5	310	337	312	339	313	340	222	241	223	242	224	243	117	
2.5D	22.5	184	198	186	199	186	200	132	141	132	142	133	143	62	
2.5D	27.5	108	113	108	113	109	114	77	80	77	81	77	81	33	
7.5D	2.5	870	862	875	867	878	870	621	615	625	619	627	621	281	
7.5D	7.5	708	683	713	687	715	689	506	488	509	490	510	492	234	
7.5D	12.5	483	457	486	459	488	461	345	326	347	328	348	329	157	
7.5D	17.5	287	282	289	284	290	285	205	201	206	203	207	203	91	
7.5D	22.5	162	157	163	158	164	158	116	112	117	112	117	113	47	
7.5D	27.5	98	91	99	92	99	92	70	65	70	66	71	66	26	
12.5D	2.5	353	354	355	357	357	358	252	253	254	254	254	255	110	
12.5D	7.5	279	284	281	286	282	287	199	203	201	204	201	205	88	
12.5D	12.5	181	190	182	192	183	192	129	136	130	137	131	137	62	
12.5D	17.5	111	121	112	122	112	122	79	86	80	87	80	87	37	
12.5D	22.5	67	74	67	75	68	75	48	53	48	53	48	54	18	
12.5D	27.5	44	48	45	48	45	48	32	34	32	34	32	34	11	
17.5D	2.5	208	211	209	212	210	213	149	151	149	152	150	152	51	
17.5D	7.5	166	174	167	175	168	176	119	124	119	125	120	125	40	
17.5D	12.5	112	121	113	122	113	122	80	86	81	87	81	87	29	
17.5D	17.5	70	81	70	81	70	81	50	58	50	58	50	58	15	
17.5D	22.5	47	54	47	54	47	54	34	38	34	39	34	39	7	
22.5D	2.5	141	141	142	142	143	142	101	101	102	101	102	102	37	
22.5D	7.5	116	120	116	121	117	121	83	86	83	86	83	86	29	
22.5D	12.5	81	85	81	86	81	86	58	61	58	61	58	61	22	
22.5D	17.5	54	59	54	59	55	59	39	42	39	42	39	42	11	
27.5D	2.5	90	89	90	90	91	90	64	64	64	64	65	64	26	
27.5D	7.5	75	77	76	78	76	78	54	55	54	55	54	56	18	

Complies: <input checked="" type="checkbox"/> YES <input type="checkbox"/> NO	
Tested By: Matthew Benninger	Signature or Initials: mb
Reviewed By: cwm	Signature or Initials: <i>cwm</i>
Test Equipment Used: 8,9,10,11	
Amb (°C): 23 RH% 31	
Comp. Date 11/23/16	

Lens Abrasion Resistance 6.4.5.2

A lens was mounted in the abrasion test fixture with the lens facing upwards. An abrading pad was cycled back and forth (1 cycle) for twelve cycles at $10\text{cm} \pm 2\text{cm}$ per second over the test surface of the lens. The abrading pad shall not be less than $2.5\text{cm} \pm 0.1\text{cm}$ square, constructed of 0000 steel wool rubber cemented to a rigid base shaped to the contour of the lens. The "grain" of the pad was perpendicular to the direction of motion. The abrading pad support was equal in size to the pad and the center of the support surface was within $\pm 2\text{mm}$ of parallel to the lens surface. The density of the abrading pad was such that when the pad was mounted to its support and is resting unweight on the lens, the base of the pad was no closer than 3.2mm to the lens at its closest point. When mounted on its support and resting on the lens, the abrading pad was weighted such that a pad pressure of $14\text{kPa} \pm 1\text{kPa}$ exists at the center and perpendicular to the face of the lens. A pivot was used to follow the contour of the lens.

Results

A single intensity point was measured before and after the abrasion. In all samples tested the abraded lens intensity measurement was at least 90% of the un-abraded lens intensity measurement.

12" Red Ball Tinted			
Sample	Pre Abrasion	Post Abrasion	Percentage
CRT1610241001-007-004	768.1	765.3	99.6
CRT1610241001-007-005	854.7	855.2	100.1
CRT1610241001-008-002	768.1	762.4	99.3

measurements in cd

12" Red Ball Clear			
Sample	Pre Abrasion	Post Abrasion	Percentage
CRT1611071057-002-004	850.5	841.3	98.9
CRT1611071057-002-005	870.5	837.8	96.2
CRT1611071057-004-004	829.4	823.5	99.3

measurements in cd

Measured Voltage:	120.3	Vac		
Measured Weight:	11.0	lbs		
Abrasion Pad	5.5	Sq. In		
Pad Pressure	2.0	psi	13.8	Kpa

Complies: ☒ YES ☐ NO

Tested By:	Matthew Benninger/VS	Signature or initials:	mb/vs	Comp. Date	12/20/2016 & 12/23/16
Reviewed By:	cwm	Signature or initials:	<i>[Signature]</i>		
Test Equipment Used:	8,9,10,11,20				
Amb (°C):	23	RH%	28		

Luminance Uniformity

Luminance measurements were taken at nine locations across the signal face. A spot size of one inch was used. The luminance meter was translated from side to side and up and down remaining normal to the sample surface. The measurements were used to determine luminance uniformity. The measurements were taken after operating on the same duty cycle used during the photometric test.

Results

The ratio between the maximum and the minimum luminance was less than 10 to 1. Data follows.

12" Red Ball Tinted			
Sample	CRT1610241001-007-004	CRT1610241001-007-005	CRT1610241001-008-002
Location	Luminance	Luminance	Luminance
1	1368	1691	1210
2	1131	1134	977
3	1233	1203	1300
4	799	1267	778
5	735	1226	765
6	570	763	640
7	1402	1252	1347
8	1178	1560	1193
9	689	1014	615
Average	1012	1234	981
Intensity Ratio	2.5 to 1.0	2.2 to 1.0	2.2 to 1.0

Note: Neutral density filter 1.0 was used for luminance measurements and are relative.

12" Red Ball Clear			
Sample	CRT1611071057-002-004	CRT1611071057-002-005	CRT1611071057-004-004
Location	Luminance	Luminance	Luminance
1	1225	1388	1760
2	1203	1152	1349
3	1212	1361	1374
4	920	1109	799
5	807	1017	904
6	1258	1223	1010
7	1019	1038	1398
8	1155	1550	1230
9	646	838	683
Average	1049	1186	1167
Intensity Ratio	1.9 to 1.0	1.8 to 1.0	2.6 to 1.0

Note: Neutral density filter 1.0 was used for luminance measurements and are relative.

Luminance measurements are in cd/m²
 Same 60 minute warm-up used for luminous intensity
 Test distance is 19 feet with ¼ degree aperture using the PR 740

Measured Voltage: 119.9 - 120.1 Vac

Complies: ☒ YES ☐ NO

Tested By:	Kurt Dobler	Signature or initials:	kfd	Comp. Date	11/11/16
Reviewed By:	cwm	Signature or initials:	<i>cwm</i>		
Test Equipment Used:	2,3,12,13				
Amb (°C):	22.1	RH%	27		

Chromaticity 6.4.4.6

The chromaticity measurements were performed on the submitted LED Traffic Signal Modules with the spectroradiometer. The samples were operated at nominal input voltage and ambient temperature during the measurements. The measurements were taken from 380-780nm in 2nm increments.

The chromaticity measurements were taken at nine locations across the signal face. A spot size of one inch was used with the samples operating on the same duty cycle used during the photometric test. The spectroradiometer was translated from side to side and up and down remaining normal to the sample surface. The average of the measurements are recorded.

Results



		Chromaticity Coordinates	
Color	Sample	x	y
Red (Tinted)	CRT1610241001-007-004	0.706	0.294
	CRT1610241001-007-005	0.705	0.294
	CRT1610241001-008-002	0.707	0.294

		Chromaticity Coordinates	
Color	Sample	x	y
Red (Clear)	CRT1611071057-002-004	0.707	0.293
	CRT1611071057-002-005	0.706	0.294
	CRT1611071057-004-004	0.705	0.294

The chromaticity measurements pass the requirements of the referenced specification.

Measured Voltage:	119.9 - 120.1	Vac
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Complies: ☒ YES ☐ NO

Tested By:	Kurt Dobler/John Robins	Signature or initials:	kfd 	Comp. Date	11/11/16
Reviewed By:	cwm	Signature or initials:			
Test Equipment Used:	2,3,12,13				
Amb (°C):	22.1	RH%	27		

Color Uniformity 6.4.4.7

Three samples of each model were tested. Nine color measurements were taken at different locations on the traffic signal face. The measurements were taken after operating on the same duty cycle used during the photometric test. The dominant wave length was found using the measured (x, y) coordinates and table 3.29 of "Color Science" by Wyszecki & Stiles.



Results

12" Red Ball Tinted									
Sample	CRT1610241001-007-004			CRT1610241001-007-005			CRT1610241001-008-002		
Location	x	y	Dominant	x	y	Dominant	x	y	Dominant
1	0.707	0.294	629	0.706	0.294	628	0.707	0.294	629
2	0.706	0.294	629	0.706	0.294	628	0.707	0.294	629
3	0.706	0.294	629	0.706	0.295	628	0.706	0.294	629
4	0.706	0.294	628	0.706	0.294	628	0.706	0.294	629
5	0.706	0.294	628	0.706	0.295	628	0.706	0.294	628
6	0.707	0.293	629	0.700	0.294	628	0.707	0.293	629
7	0.706	0.294	629	0.706	0.294	628	0.707	0.294	629
8	0.706	0.294	628	0.706	0.294	628	0.706	0.294	629
9	0.706	0.294	628	0.706	0.295	628	0.706	0.294	628
Average	0.706	0.294	629	0.705	0.294	628	0.707	0.294	629

12" Red Ball Clear									
Sample	CRT1611071057-002-004			CRT1611071057-002-005			CRT1611071057-004-004		
Location	x	y	Dominant	x	y	Dominant	x	y	Dominant
1	0.707	0.293	629	0.706	0.294	628	0.706	0.294	628
2	0.707	0.293	629	0.706	0.294	628	0.705	0.294	628
3	0.707	0.293	629	0.706	0.294	628	0.705	0.294	628
4	0.707	0.293	629	0.706	0.294	628	0.705	0.294	628
5	0.707	0.293	629	0.706	0.294	628	0.706	0.294	628
6	0.707	0.293	629	0.706	0.294	628	0.706	0.294	628
7	0.707	0.293	629	0.706	0.294	628	0.706	0.294	628
8	0.706	0.293	629	0.705	0.294	628	0.705	0.294	628
9	0.706	0.293	628	0.705	0.295	628	0.705	0.295	628
Average	0.707	0.293	629	0.706	0.294	628	0.705	0.294	628

Measured Voltage: 119.9 - 120.1 Vac

Complies: ☒ YES ☐ NO

Tested By:	Kurt Dobler/John Robins	Signature or initials:	kfd 	Comp. Date	11/11/16
Reviewed By:	cwm	Signature or initials:			
Test Equipment Used:	2,3,12,13				
Amb (°C):	22.1	RH%	27		

Current Consumption 6.4.6.1

Three samples were measured for current flow in amperes. The measured current values are supplied for comparison of Product Quality Assurance current measurements on production modules. Current measurements were taken at start up.

Results



Measurements are in (mA)

12" Red Ball			
Sample	-40°C	25°C	74°C
CRT1610241001-007-001	73.3	63.3	60.4
CRT1610241001-007-002	73.4	63.5	61.1
CRT1610241001-007-003	72.9	63.5	60.9

The current consumption was not in excess of 120% of the label current values for an ambient temperature of 25°C.

Measured Voltage: 120.1 Vac

Complies: ☒ YES ☐ NO

Tested By:	John Robins	Signature or initials:		Comp. Date:	11/10/16
Reviewed By:	cwm	Signature or initials:			
Test Equipment Used:	1,15				
Amb (°C):	na	RH%	na		

Low Voltage Turn Off 6.4.6.2

Three samples were measured to ensure compliance with the low voltage turn-off requirement. Each sample was fully illuminated at the nominal operating voltage. The applied voltage was then reduced to the point where there was no visible illumination.

Results

There was no visible illumination when the applied voltage was less than 35Vac RMS.

12" Red Ball	
Sample	Low Voltage Turn Off (Vac RMS)
CRT1610241001-007-001	62.9
CRT1610241001-007-002	63.2
CRT1610241001-007-003	63.7

Complies: ☒ YES ☐ NO

Tested By:	Kurt Dobler	Signature or initials:	kfd	Comp. Date:	11/9/16
Reviewed By:	cwm	Signature or initials:	<i>cwm</i>		
Test Equipment Used:	2,16				
Amb (°f):	72	RH%	37		

Turn-On/Turn-Off Times 6.4.6.3

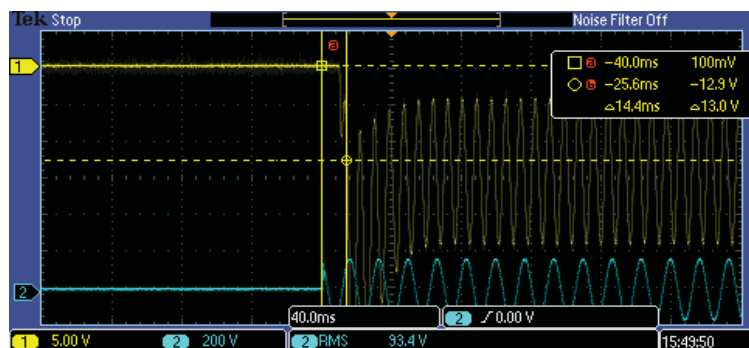
Three samples were measured to ensure compliance with the turn-on and turn-off requirements. The measurements were conducted using a two channel oscilloscope to measure the time delay between when the samples are energized at 120 Vac RMS and when the light output reaches 90% of full output. The same test equipment was used to measure the time delay between when the sample is de-energized and when the light output reaches 0% of full output.

Results

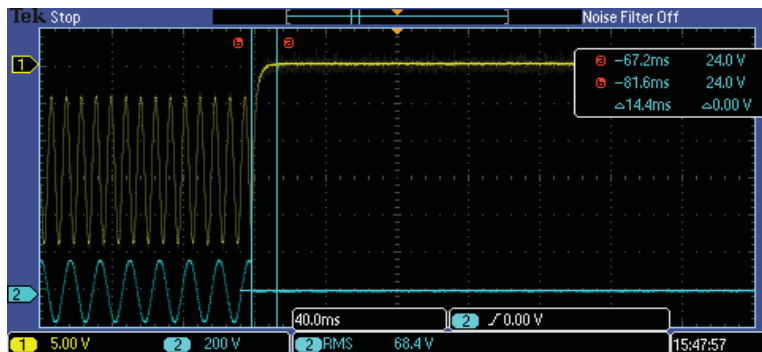
12" Red Ball		
Sample	Turn On	Turn Off
CRT1610241001-007-001	11.2	10.4
CRT1610241001-007-002	15.2	10.4
CRT1610241001-007-003	14.4	14.4

The "on" time and "off" time were within the 75ms requirement on all samples tested.

Sample Turn On Time



Sample Turn Off Time



Measured Voltage: 120 Vac

Complies: ☒ YES ☐ NO

Tested By:	John Robins	Signature or initials:	<i>JR</i>	Comp. Date:	12/6/16
Reviewed By:	cwm	Signature or initials:	<i>cwm</i>		
Test Equipment Used:	16,18,19				
Amb (°f):	72	RH%	28		

Transient Voltage Immunity 6.4.6.4

Three samples were subjected to 3 positive and 3 negative 1000V 7.5 joule pulses across their input leads at a rate of 0.5 pps in accordance with NEMA TS 2-2003 section 2.1.8. The pulses were the discharge from a 15µF capacitor. The devices were then energized with rated voltage to verify proper operation.

Results

The signal modules withstood the applications of the transient voltage without damage or operational deterioration.

12" Red Ball			
Sample	3 Positive Pulses	3 Negative Pulses	Results
CRT1610241001-007-001	x	x	Pass
CRT1610241001-007-002	x	x	Pass
CRT1610241001-007-003	x	x	Pass

Measured Voltage:	1000	Vdc
Measured Capacitance:	15.8 - 16.6	µF

Complies: ☒ YES ☐ NO

Tested By:	Kurt Dobler	Signature or initials:	kfd	Comp. Date:	12/8/16
Reviewed By:	cwm	Signature or initials:	<i>cwm</i>		
Test Equipment Used:	2,16				
Amb (°f):	72	RH%	30		

Electronic Noise 6.4.6.5

Three LED traffic signal modules were operated at 120 VAC/60Hz throughout the test. Emissions measurements were taken to compare values to applicable requirements.

Results

The emissions complied with the requirements of the referenced specification. The testing was performed at our Oakdale, MN office. See report: 102472631MIN-014R

Complies: ☒ YES ☐ NO

Tested By:	Richard Blonigen	Signature or initials:	See Report	Comp. Date:	12/21/16
Reviewed By:	Uri Spector	Signature or initials:	See Report		
Test Equipment Used:	See Report				
Amb (°C):	See Report	RH%:	See Report		

Power Factor & Total Harmonic Distortion 6.4.6.6 & 6.4.6.7



Three samples were measured for power factor and total harmonic distortion. A commercially available power analyzer was used to perform these measurements.

Results

12" Red Ball						
Sample	Voltage	Current (mA)	Power (W)	Power Factor	THD V%	THD I%
CRT1610241001-007-001	119.9	61.9	7.2	0.97	0.79	14.2
CRT1610241001-007-002	120.0	62.2	7.2	0.97	0.80	14.2
CRT1610241001-007-003	120.0	62.1	7.2	0.97	0.78	14.5
Requirement	NA	NA	NA	≥ 0.90	≤ 20%	≤ 20%

Measurements taken after a minimum 60 minute warmup.

Complies: ☒ YES ☐ NO

Tested By:	John Robins	Signature or initials:		Comp. Date	11/8/16
Reviewed By:	cwm	Signature or initials:			
Test Equipment Used:	15,16				
Amb (°f):	72	RH%	30		

Load Switch Compatibility 6.4.7.1

Three samples were connected to a variable AC voltage supply. The sample was monitored for sufficient current draw to ensure proper load switch operation while the voltage is varied from 80V rms to 135 V rms.

Results

The load switch data is provided to the client to determine if the current draw is acceptable. The referenced ITE specification does not list a minimum current draw requirement. As a result, the Caltrans Standard Specifications dated 2010, Section 86-4.01D(2)(a) must be followed listing a minimum power consumption requirement of 5 watts for 12" traffic signal modules.

12" Red Ball		
Sample	80 Vrms	135 Vrms
CRT1610241001-007-001	87.5	62.3
CRT1610241001-007-002	88.5	62.0
CRT1610241001-007-003	88.2	62.1



Current measurements are in mA

12" Red Ball		
Sample	80 Vrms	135 Vrms
CRT1610241001-007-001	6.8	7.5
CRT1610241001-007-002	6.8	7.6
CRT1610241001-007-003	6.8	7.5

Power measurements are in watts.

Measured Voltage 80Vac:	80.1	Vac
Measured Voltage 135Vac:	135	Vac

Complies: ☒ YES ☐ NO

Tested By:	John Robins	Signature or initials:		Comp. Date:	11/9/16
Reviewed By:	cwm	Signature or initials:			
Test Equipment Used:	15,16				
Amb (°f):	73	RH%	38		

Off State Voltage Decay 6.4.7.2

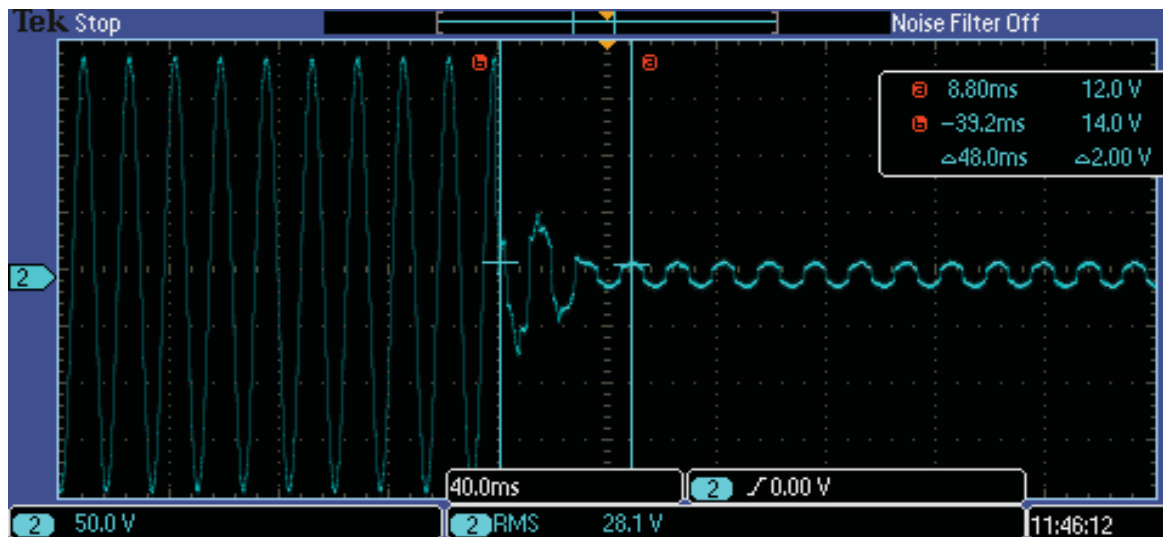
Three samples were operated from a 135V AC voltage supply. A 19.5 k-ohm resistor was wired in series in the hot line between the LED signal monitor and the AC power supply. A single-pole-single-throw switch was wired in parallel across the 19.5 k-ohm resistor. A 220 k-ohm shunt resistor was wired between the hot line connection and the neutral line connection on the LED signal module. The single-pole-single-throw switch was closed, shorting out the 19.5 k-ohm resistor, allowing the AC power supply to illuminate the LED signal module. Next the switch was opened and the voltage across the 220 k-ohm shunt resistor was measured for a decay to a value equal to or less than 10V rms within a time period equal to or less than 100 milliseconds. The test was repeated a sufficient number of times to ensure testing occurs at the peak of the AC line voltage cycle.

Results

12" Red Ball	
sample	Decay Time (mS)
CRT1610241001-007-001	32.8
CRT1610241001-007-002	48.0
CRT1610241001-007-003	48.0

In all samples measured the decay time was less than 100mS.

Sample Screen Shot



Measured Voltage: 135 Vac

Complies: ☒ YES ☐ NO

Tested By:	John Robins	Signature or initials:	<i>JR</i>	Comp. Date:	12/7/16
Reviewed By:	cwm	Signature or initials:	<i>cwm</i>		
Test Equipment Used:	16,18,19				
Amb (°C):	72	RH%	29		

Failed State Impedance 6.4.8

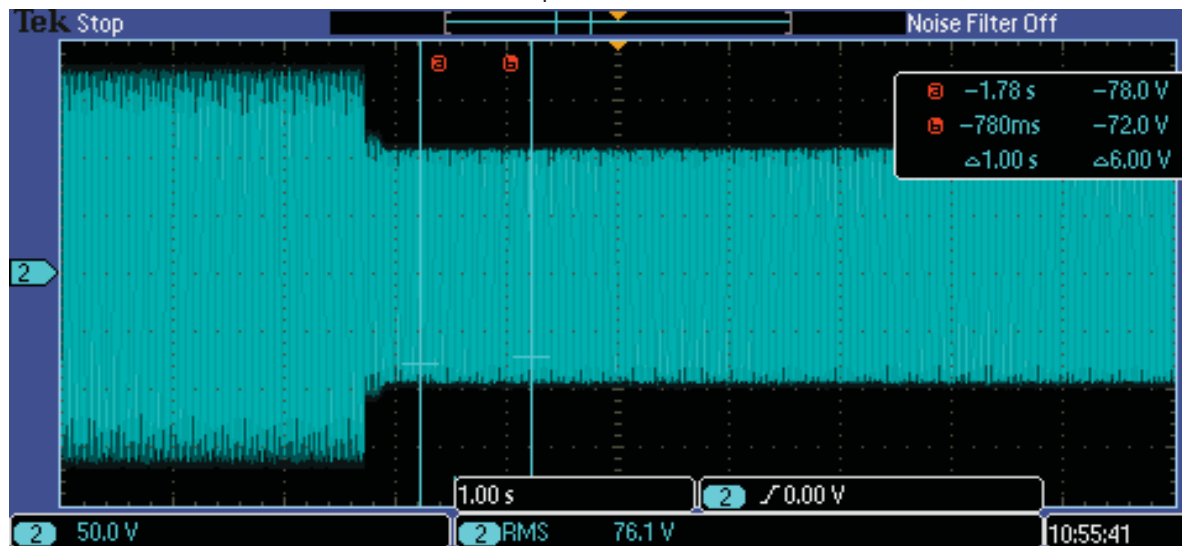
First the LED board is disconnected from the signal power supply. Then the LED signal modules are operated from a 120V AC voltage supply. A 50k-ohm resistor is wired in series in the hot line between the LED signal module and the AC power supply. A single-pole-single-throw switch is wired in parallel across the 50k-ohm resistor. A 100 k-ohm shunt resistor is wired between the hot line connection and the neutral line connection on the LED signal module. The single-pole-single-throw switch is opened and the voltage across the 100 k-ohm shunt resistor is measured from 500mS through 1500mS, after energizing the circuit with the open switch. The test was repeated 10 times.

Results

12" Red Ball	
sample	Vrms
CRT1610241001-007-001	76.0
CRT1610241001-007-002	76.1
CRT1610241001-007-003	76.1

In all samples tested the voltage across the 100K Ω resistor was greater than 70 Vac RMS.

Sample Screen Shot



Measured Voltage: 120 Vac

Complies: ☒ YES ☐ NO

Tested By:	John Robins	Signature or initials:	<i>JR</i>	Comp. Date	2/27/17
Reviewed By:	JND	Signature or initials:	<i>JND</i>		
Test Equipment Used:	16,18,19				
Amb (°C):	72	RH%	24		

Equipment list				
#	Intertek ID No.	Description	Manufacturer	Calibration Due
1	H204	Chamber	Thermotron	10-Nov-2017
2	M207	Digital Multimeter	Fluke	17-Sep-2017
3	T1486	Digit Hygro-Thermometer	Extech	16-Mar-2017
4	V272	Signal Conditioner	Unholtz-Dickie	27-Jun-2017
5	V393	Vibration Controller	Unholtz-Dickie	15-Jul-2017
6	V328	Accelerometer	PCB Piezotronics	2-Dec-2016
7	V334	Accelerometer	PCB Piezotronics	18-Feb-2017
8	O109	Goniometer	Optroniks	3-Oct-2017
9	O115	25M Photometer	Optroniks	24-Oct-2017
10	T1555	Hygro-Thermometer	Extech	3-May-2017
11	M135	Multimeter	Fluke	4-Apr-2017
12	O757	Spectra Scan	Photo Research	23-Mar-2017
13	R153	Distance Meter	Leica	7-Dec-2016
14	O719	flexOptometer	UDT	3-Dec-2016
15	G032S	Power Analyzer	Yokogawa	9-May-2017
16	T835	Temp/Humidity	Supco	10-Jun-2017
17	T804	Digital Thermometer	Fluke	16-May-2017
18	V244	High Voltage Probe	Tektronix	3-Nov-2017
19	E470	Oscilloscope	Tektronix	8-Jul-2017
20	S159	Push Pull Scale	Controls International	7-Jan-2017
21	N1153	Rain Gauge	Pyrex	6-Jan-2019
22	T804	Thermometer	Fluke	16-May-2017
23	N1419	Stopwatch	Control Co	16-Aug-2017
24	Y205	Anemometer	Omega	23-May-2017
Note: For measurement uncertainty, refer to the calibration certificates for all the test equipment located in the equipment files				



Issue Date: January 27, 2017
Project No. G102785964
Quote No.: Qu-00734330

Contact: Hamid Kashani
Email: hamid@leotek.com
Phone No. 408-380-1788

Report No. 102785964CRT-001Y

Leotek Electronics USA LLC

1955 Lundy Ave
San Jose, CA 95131

Standards

Performance Specification of the Institute of Transportation Engineers, Vehicle Traffic Control Signal Heads: Light Emitting Diode (LED) Vehicle Arrow Traffic Signal Supplement, dated July 1, 2007.

Standard Specifications Caltrans dated 2010. Section 86-4.01D(2)(a)

Test Purpose	ITE 5-Year Re-Certification Testing of Models; TSL-12YA-IL6-A1 & TSL-12YA-IL6-A1-CLR
Test Dates	October 27, 2016 through January 27, 2017

John C. Robins
Engineer
Lighting

Christopher W. Metcalf
Engineering Supervisor
Lighting

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Test Plan and Datasheets			
Client	Leotek Electronics USA LLC	Engineer	John C. Robins
Report #	102785964CRT-001Y	Reviewer	Christopher W. Metcalf
Product	12" Yellow Omni Arrow Tinted & Clear	Model(s)	TSL-12YA-IL6-A1 & TSL-12YA-IL6-A1-CLR
Standard	ITE, Vehicle Arrow Traffic Signal Supplement, dated July 1, 2007.		

Spec	Test name	Clause	Pass Fail NA
ITE	Conditioning	6.4.2	Pass
ITE	Mechanical Vibration	6.4.3.1	Pass
ITE	Temperature Cycling	6.4.3.2	Pass
ITE	Moisture Resistance	6.4.3.3	Pass
ITE	Luminous Intensity	6.4.4.1, 2,3,4	Pass
ITE	Luminance Uniformity	6.4.4.5	Pass
ITE	Chromaticity	6.4.4.6	Pass
ITE	Color Uniformity	6.4.4.7	Pass
ITE	Lens Abrasion Resistance	6.4.5.2	Pass
ITE	Current Consumption	6.4.6.1	Pass
ITE	Low Voltage Turn Off	6.4.6.2	Pass
ITE	Turn-On/Turn-Off Times	6.4.6.3	Pass
ITE	Transient Voltage Immunity	6.4.6.4	Pass
ITE	Electronic Noise	6.4.6.5	Pass
ITE	Power Factor & Total Harmonic Distortion	6.4.6.6, 7	Pass
ITE	Load Switch Compatibility	6.4.7.1	Pass
ITE	Off State Voltage Decay	6.4.7.2	Pass
ITE	Failed State Impedance	6.4.8	Pass

Sample Information				
Date Rec.	Intertek ID	Description	Condition	Model No.
10/24/2016	CRT1610241001-001	12" Yellow Omni Arrow	Production	TSL-12YA-IL6-A1
10/24/2016	CRT1610241001-002	12" Yellow Omni Arrow	Production	TSL-12YA-IL6-A1
11/7/2016	CRT1611071057-003	12" Yellow Omni Arrow Clear	Production	TSL-12YA-IL6-A1-CLR

Further Sample Description

Intertek Sample Number	Description	Model Number	Serial Number
CRT1610241001-001-001	12" Yellow Omni Arrow	TSL-12YA-IL6-A1	16917551
CRT1610241001-001-002	12" Yellow Omni Arrow	TSL-12YA-IL6-A1	16917552
CRT1610241001-001-003	12" Yellow Omni Arrow	TSL-12YA-IL6-A1	16917553
CRT1610241001-001-004	12" Yellow Omni Arrow	TSL-12YA-IL6-A1	16917554
CRT1610241001-001-005	12" Yellow Omni Arrow	TSL-12YA-IL6-A1	16917555
CRT1610241001-002-002	12" Yellow Omni Arrow	TSL-12YA-IL6-A1	16917556
CRT1611071057-003-002	12" Yellow Omni Arrow Clear	TSL-12YA-IL6-A1-CLR	T16B024
CRT1611071057-003-003	12" Yellow Omni Arrow Clear	TSL-12YA-IL6-A1-CLR	T16B022
CRT1611071057-003-004	12" Yellow Omni Arrow Clear	TSL-12YA-IL6-A1-CLR	T16B023

General Requirements

Intertek Sample Number	ETL Cert. Number	Label Identification	Lens Orientation	Color Coded Wires
CRT1610241001-001-001	7080621	Pass	Pass	Yellow/White
CRT1610241001-001-002	7080622	Pass	Pass	Yellow/White
CRT1610241001-001-003	7080623	Pass	Pass	Yellow/White
CRT1610241001-001-004	7080624	Pass	Pass	Yellow/White
CRT1610241001-001-005	7080625	Pass	Pass	Yellow/White
CRT1610241001-002-002	7080626	Pass	Pass	Yellow/White
CRT1611071057-003-002	6519674	Pass	Pass	Yellow/White
CRT1611071057-003-003	6511559	Pass	Pass	Yellow/White
CRT1611071057-003-004	4574885	Pass	Pass	Yellow/White

General Requirements

Intertek Sample Number	600V / 20 AWG Min.	Wire Length \geq 39"	Service Rating +105°C
CRT1610241001-001-001	600V/18AWG	Pass	Pass
CRT1610241001-001-002	600V/18AWG	Pass	Pass
CRT1610241001-001-003	600V/18AWG	Pass	Pass
CRT1610241001-001-004	600V/18AWG	Pass	Pass
CRT1610241001-001-005	600V/18AWG	Pass	Pass
CRT1610241001-002-002	600V/18AWG	Pass	Pass
CRT1611071057-003-002	600V/18AWG	Pass	Pass
CRT1611071057-003-003	600V/18AWG	Pass	Pass
CRT1611071057-003-004	600V/18AWG	Pass	Pass

Picture(s)

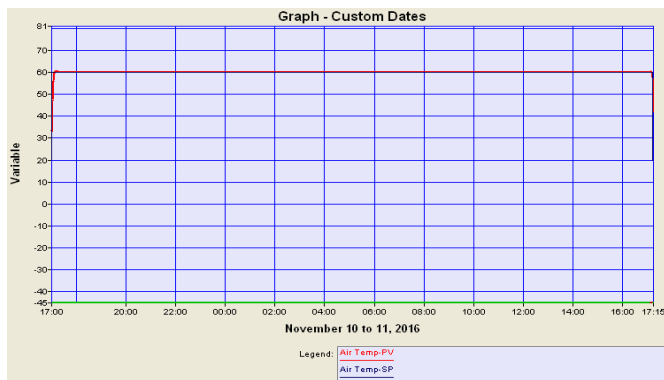
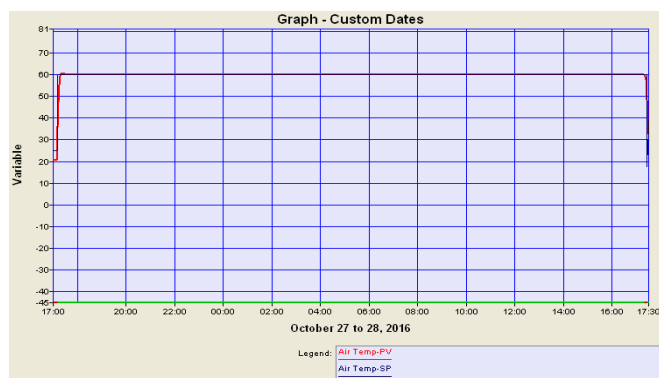


Conditioning 6.4.2

The submitted LED signal modules were subjected to conditioning prior to the environmental tests. The samples were energized for a minimum of 24 hours, at 100% duty cycle in an ambient temperature of +60°C (+140°F). At the conclusion of the test, the modules shall be visually inspected for damage and checked for proper operation.

Results

Intertek Sample Number	Description	Visual Inspection		Operational Check	
		Pre	Post	Pre	Post
CRT1610241001-001-001	12" Yellow Omni Arrow	Pass	Pass	Pass	Pass
CRT1610241001-001-002	12" Yellow Omni Arrow	Pass	Pass	Pass	Pass
CRT1610241001-001-003	12" Yellow Omni Arrow	Pass	Pass	Pass	Pass
CRT1610241001-001-004	12" Yellow Omni Arrow	Pass	Pass	Pass	Pass
CRT1610241001-001-005	12" Yellow Omni Arrow	Pass	Pass	Pass	Pass
CRT1610241001-002-002	12" Yellow Omni Arrow	Pass	Pass	Pass	Pass
CRT1611071057-003-002	12" Yellow Omni Arrow Clear	Pass	Pass	Pass	Pass
CRT1611071057-003-003	12" Yellow Omni Arrow Clear	Pass	Pass	Pass	Pass
CRT1611071057-003-004	12" Yellow Omni Arrow Clear	Pass	Pass	Pass	Pass



Measured Voltage: 119.3 Vac

Complies: ☒ YES ☐ NO

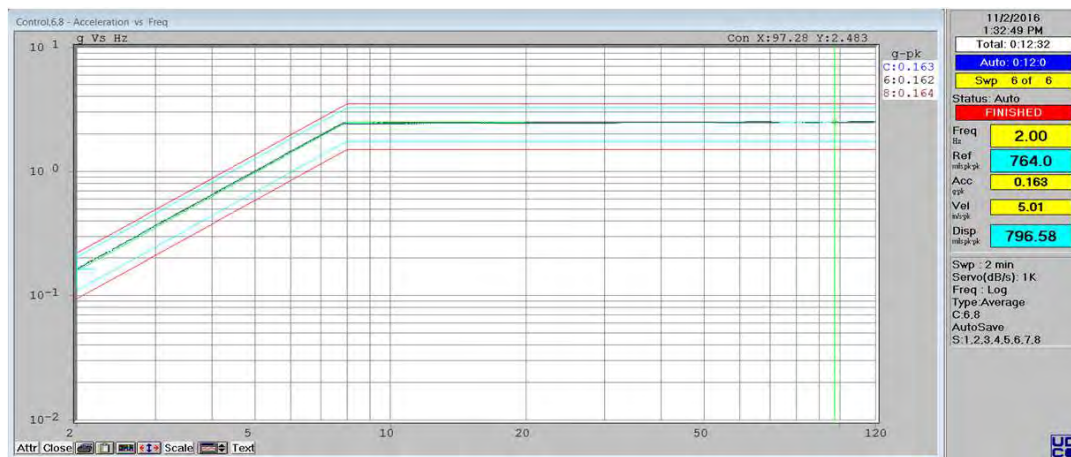
Tested By:	John Robins	Signature or initials:	<i>JR</i>	Comp. Date	10/28/16
Reviewed By:	cwm	Signature or initials:	<i>cwm</i>	Comp. Date	11/11/2016
Test Equipment Used:	1,2				
Amb (°C):	na	RH%	na		

Mechanical Vibration 6.4.3.1

The submitted LED signal modules were securely mounted in traffic signal housings and vibrated along each axes for three 4 minute sweep cycles at a displacement of 0.764" from 2 to 8 Hz and 2.5 Gs from 8 to 120 Hz. The modules were energized before and after each axis sweep. The modules were visually inspected after testing. Testing was conducted in accordance with MIL-STD-883, method 2007. At the conclusion of the test, the module shall be free of damage and fully operational.

Results

Intertek Sample Number	Description	x-axis lateral	y-axis horizontal	z-axis vertical	Visual Inspection	Operational Check
CRT1610241001-001-001	12" Yellow Omni Arrow	X	X	X	Pass	Pass
CRT1610241001-001-002	12" Yellow Omni Arrow	X	X	X	Pass	Pass
CRT1610241001-001-003	12" Yellow Omni Arrow	X	X	X	Pass	Pass
CRT1610241001-001-004	12" Yellow Omni Arrow	X	X	X	Pass	Pass
CRT1610241001-001-005	12" Yellow Omni Arrow	X	X	X	Pass	Pass
CRT1610241001-002-002	12" Yellow Omni Arrow	X	X	X	Pass	Pass

Complies: ☒ YES ☐ NO

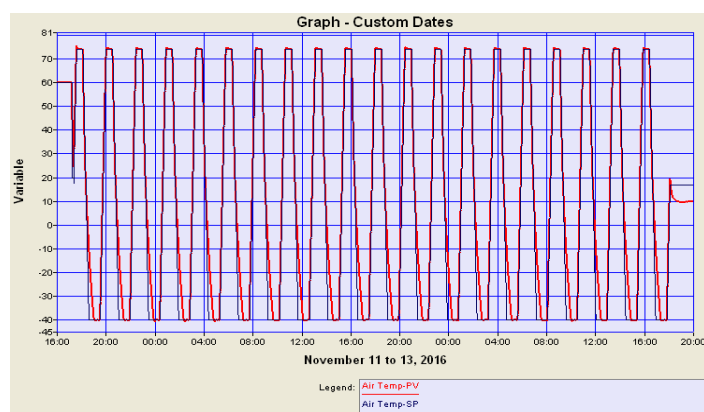
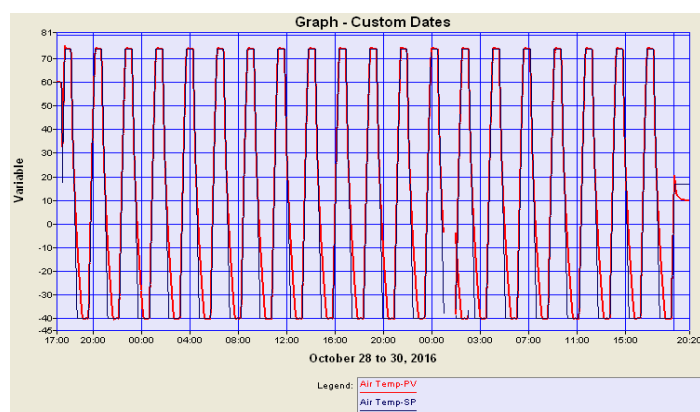
Tested By:	Gordon West	Signature or initials:	<i>Gordon West</i>	Comp. Date	11/3/16
Reviewed By:	cwm	Signature or initials:	<i>cwm</i>		
Test Equipment Used:	3,4,5,6,7				
Amb (°C):	23.1	RH%	41		

Temperature Cycling 6.4.3.2

The submitted tinted and clear LED signal modules were subjected to temperature cycling according to MIL-STD-883, Method 1010. Twenty cycles were performed with a 30 minute transfer time between temperature extremes and a 30 minute dwell time at the extremes. The temperature cycled between -40°C and +74°C. The samples were non-operating. At the conclusion of the test, the module shall be free of damage and moisture and be fully operational.

Results

Intertek Sample Number	Description	Visual Inspection	Operational Check
CRT1610241001-001-001	12" Yellow Omni Arrow	Pass	Pass
CRT1610241001-001-002	12" Yellow Omni Arrow	Pass	Pass
CRT1610241001-001-003	12" Yellow Omni Arrow	Pass	Pass
CRT1610241001-001-004	12" Yellow Omni Arrow	Pass	Pass
CRT1610241001-001-005	12" Yellow Omni Arrow	Pass	Pass
CRT1610241001-002-002	12" Yellow Omni Arrow	Pass	Pass
CRT1611071057-003-002	12" Yellow Omni Arrow Clear	Pass	Pass
CRT1611071057-003-003	12" Yellow Omni Arrow Clear	Pass	Pass
CRT1611071057-003-004	12" Yellow Omni Arrow Clear	Pass	Pass



Complies: ☒ YES ☐ NO

Tested By:	John Robins	Signature or initials:	<i>JR</i>	Comp. Date:	10/30/16
Reviewed By:	cwm	Signature or initials:	<i>cwm</i>	Comp. Date:	11/13/2016
Test Equipment Used:	2				
Amb (°C):	na	RH%	na		

Moisture Resistance 6.4.3.3

The submitted tinted and clear LED signal modules were subjected to the rain and blowing rain test per MIL-STD-810F, Test Method 506.4, Procedure I. The test was performed on standalone modules without a protective housing. The rainfall rate was 1.7 mm/min (4in/hr) and the droplet size shall predominantly be between 0.5mm and 4.5mm (0.02 to 0.18 in). The samples were oriented such that the lens is directed towards the wind source when at a zero rotation angle. The samples were rotated at a rate of 4 degrees per minute along the vertical axis, from an orientation of -60 to +60 degrees during the test. The duration of the test is 30 minutes, and the samples were energized throughout the test. The water temperature was $25^{\circ} \pm 5^{\circ}\text{C}$ ($77^{\circ} \pm 9^{\circ}\text{F}$) and the wind velocity was 80 km/hr (50 mph). At the conclusion of the test, the module shall be free of damage and moisture and be fully operational.

Results

Intertek Sample Number	Description	Visual Inspection	Operational Check
CRT1610241001-001-001	12" Yellow Omni Arrow	pass	pass
CRT1610241001-001-002	12" Yellow Omni Arrow	pass	pass
CRT1610241001-001-003	12" Yellow Omni Arrow	pass	pass
CRT1610241001-001-004	12" Yellow Omni Arrow	pass	pass
CRT1610241001-001-005	12" Yellow Omni Arrow	pass	pass
CRT1610241001-002-002	12" Yellow Omni Arrow	pass	pass
CRT1611071057-003-002	12" Yellow Omni Arrow Clear	pass	pass
CRT1611071057-003-003	12" Yellow Omni Arrow Clear	pass	pass
CRT1611071057-003-004	12" Yellow Omni Arrow Clear	pass	pass

Requirement: Signal Still Operational and No Moisture In The Housing

Intertek Sample Number	Sample Temp. at start (°C)	Water Temperature 25C +/- 5C			
		Start	10 minutes in.	20 minutes in.	30 minutes in.
CRT1610241001-001-001	40	26.3	26.2	27.2	28.9
CRT1610241001-001-002	40				
CRT1610241001-001-003	40	27.0	29.9	28.5	29.8
CRT1610241001-001-004	40				
CRT1610241001-001-005	40	23.7	26.6	29.9	29.8
CRT1610241001-002-002	40				
CRT1611071057-003-002	40	29.3	21.7	27.2	23.7
CRT1611071057-003-003	40				
CRT1611071057-003-004	40	26.8	27.4	27.1	27.3

* Water temperature is °C

Recorded rainfall rate:	4.3	in/hr
Recorded wind velocity:	48-52	mph

Complies: ☒ YES ☐ NO

Tested By:	Kurt Dobler	Signature or initials:	kfd	Comp. Date	1/26/17
Reviewed By:	cwm	Signature or initials:	<i>cwm</i>		
Test Equipment Used:	20,21,22,23				
Amb (°C):	na	RH%	na		

Luminous Intensity 6.4.4.1 through 6.4.4.4

The intensity distribution tests on the submitted LED traffic signal modules were performed with the Intertek 25 meter Goniophotometer. The goniophotometer was in accordance with the goniometer described in Section 11.02 (Test Apparatus) of the Institute of Transportation Engineers' Vehicle Traffic Control Signal Heads Standard Test Method. The calibration of the goniophotometer is traceable to the National Institute of Standards and Technology. The LED modules were operated at 120 volts AC. The alignment of the LED module was performed in accordance with Section 11.03 (Alignment of Optical Unit for Test) of the Institute of Transportation Engineers' Vehicle Traffic Control Signal Heads Standard Test Method.

The submitted LED signal modules were tested for maintained minimum luminous intensity at each of 112 points indicated in Table 3, of the referenced specification. These measurements were recorded at an ambient temperature of 25°C. The yellow LED signal modules was operated on a 12 ½ % duty cycle for 1 hour (5 second "on" / 35 seconds "off" duty cycle). A measurement was taken at the end of the duty cycle and the module was then operated at a 100% duty cycle until stabilized. A factor was generated to rate the stable data back to the end of the 12½% duty cycle. A relative luminous intensity measurement is taken in a region from 0 to 7.5° down, and from 7.5° left to 7.5° right. The measurement is taken at 80 Vac, 120 Vac and 135 Vac. When the 80 Vac and 135 Vac factors are applied to the photometric data the units shall still meet the photometric requirements of each model.

A diminution factor was measured by using the submitted samples. The modules were mounted in a dual compartment temperature chamber with the lensed portion in one compartment and all portions behind the lens within the other compartment. At room ambient temperature (both inside and outside the chamber) and in calm air outside the chamber, the modules were energized per the conditions described above and a single on-axis reading (IA) taken and recorded. With the modules off, the chamber was heated to 74°C behind the lens and 49°C in front of the lens, and allowed to stabilize. Following stabilization, the modules were energized per the above cycle and the single on-axis reading (IH) taken and recorded. A diminution factor was calculated (IH/IA). The readings recorded initially were factored by the diminution factor.

Luminous Intensity 6.4.4.1 through 6.4.4.4

Sample	CRT1610241001-001-004				Target Input voltage		Measured Input Voltage		0, 0 Lum. Intensity		Vac Variation Factor		MMLI Factor	
Module	12" Omni Arrow				80Vac		80.2 Vac		238.2 Candela		0.985		0.892	
Color:	Yellow				120Vac		120.4 Vac		241.9 Candela		1.000		5/35 Factor	
Lens	Tinted				135Vac		135.1 Vac		239.6 Candela		0.990		1.054	
Photometric Test Distance: 25 meters														
Max	436.8	25°C		25°C		25°C		74°C/49°C		74°C/49°C		74°C/49°C		
Vertical	Horizontal	Rated 80Vac		Measured 120Vac		Rated 135Vac		Rated 80Vac		Measured 120Vac		Rated 135Vac		Table 3
Angle	Angle	Candela	Candela	Candela	Candela	Candela	Candela	Candela	Candela	Candela	Candela	Candela	Candela	Minimum
Up/Down	Left/Right	Left	Right	Left	Right	Left	Right	Left	Right	Left	Right	Left	Right	Candela
27.5U	7.5	21.1	22.5	21.4	22.9	21.2	22.7	18.8	20.1	19.1	20.4	19.0	20.2	6.9
27.5U	2.5	26.0	26.4	26.4	26.8	26.1	26.5	23.2	23.5	23.5	23.9	23.3	23.7	8.2
22.5U	17.5	15.4	17.5	15.6	17.8	15.5	17.6	13.8	15.6	14.0	15.9	13.8	15.7	7.2
22.5U	12.5	24.1	25.6	24.5	26.0	24.2	25.7	21.5	22.8	21.8	23.2	21.6	23.0	12.4
22.5U	7.5	38.3	39.2	38.9	39.8	38.6	39.4	34.2	35.0	34.7	35.5	34.4	35.2	17.7
22.5U	2.5	51.8	50.6	52.6	51.4	52.1	50.9	46.2	45.2	47.0	45.9	46.5	45.5	21.2
17.5U	22.5	15.8	17.5	16.0	17.8	15.9	17.6	14.1	15.6	14.3	15.9	14.1	15.7	7.2
17.5U	17.5	25.6	27.2	26.0	27.6	25.8	27.3	22.9	24.2	23.2	24.6	23.0	24.4	15.0
17.5U	12.5	46.4	48.2	47.1	49.0	46.7	48.5	41.4	43.0	42.1	43.7	41.7	43.3	26.1
17.5U	7.5	79.9	79.3	81.1	80.6	80.3	79.8	71.3	70.8	72.4	71.9	71.7	71.2	37.7
17.5U	2.5	110.2	107.0	111.9	108.6	110.8	107.6	98.3	95.5	99.9	97.0	98.9	96.0	45.3
12.5U	22.5	23.6	25.8	24.0	26.2	23.8	26.0	21.1	23.1	21.4	23.4	21.2	23.2	12.4
12.5U	17.5	45.0	48.0	45.7	48.8	45.3	48.3	40.2	42.9	40.8	43.5	40.4	43.1	26.1
12.5U	12.5	84.9	89.3	86.2	90.7	85.4	89.8	75.8	79.7	77.0	80.9	76.2	80.1	45.7
12.5U	7.5	139.1	134.0	141.3	136.1	140.0	134.8	124.2	119.6	126.1	121.5	124.9	120.3	66.5
12.5U	2.5	182.1	175.3	184.9	178.1	183.2	176.4	162.5	156.5	165.0	158.9	163.5	157.4	80.1
7.5U	27.5	17.6	19.8	17.9	20.1	17.7	19.9	15.7	17.6	16.0	17.9	15.8	17.8	6.9
7.5U	22.5	37.2	42.3	37.8	42.9	37.5	42.5	33.2	37.7	33.8	38.3	33.4	38.0	17.7
7.5U	17.5	75.9	84.2	77.1	85.5	76.4	84.7	67.8	75.2	68.8	76.3	68.2	75.6	37.7
7.5U	12.5	136.9	133.8	139.0	135.9	137.7	134.6	122.1	119.5	124.0	121.3	122.9	120.2	66.5
7.5U	7.5	202.3	190.1	205.5	193.0	203.5	191.2	180.6	169.6	183.4	172.3	181.6	170.6	97.0
7.5U	2.5	227.3	222.7	230.9	226.1	228.7	224.0	202.9	198.7	206.0	201.8	204.1	199.9	117.1
2.5U	27.5	21.5	26.2	21.9	26.7	21.7	26.4	19.2	23.4	19.5	23.8	19.3	23.6	8.2
2.5U	22.5	53.5	58.8	54.3	59.8	53.8	59.2	47.8	52.5	48.5	53.3	48.0	52.8	21.2
2.5U	17.5	113.1	114.1	114.8	115.9	113.8	114.8	100.9	101.9	102.5	103.4	101.5	102.5	45.3
2.5U	12.5	180.3	179.5	183.1	182.3	181.4	180.5	160.9	160.2	163.4	162.7	161.9	161.1	80.1
2.5U	7.5	228.4	227.3	231.9	230.9	229.7	228.7	203.8	202.9	207.0	206.0	205.0	204.1	117.1
2.5U	2.5	250.7	250.9	254.6	254.8	252.1	252.4	223.7	223.9	227.2	227.4	225.0	225.2	141.6
2.5D	2.5	255.0	246.0	259.0	249.8	256.5	247.4	227.6	219.6	231.1	223.0	228.9	220.8	141.6
2.5D	7.5	233.9	216.3	237.5	219.7	235.2	217.6	208.7	193.1	212.0	196.1	209.9	194.2	117.1
2.5D	12.5	189.0	176.4	192.0	179.1	190.2	177.4	168.7	157.4	171.3	159.9	169.7	158.3	80.1
2.5D	17.5	122.5	124.2	124.4	126.1	123.3	124.9	109.4	110.8	111.1	112.6	110.0	111.5	45.3
2.5D	22.5	58.1	61.0	59.0	61.9	58.5	61.3	51.9	54.4	52.7	55.3	52.2	54.7	21.2
2.5D	27.5	22.5	24.5	22.9	24.9	22.7	24.6	20.1	21.9	20.4	22.2	20.2	22.0	8.2
7.5D	2.5	234.4	230.7	238.0	234.3	235.8	232.1	209.2	205.9	212.4	209.1	210.4	207.2	117.1
7.5D	7.5	209.5	196.9	212.7	200.0	210.7	198.1	187.0	175.8	189.9	178.5	188.1	176.8	97.0
7.5D	12.5	152.3	144.3	154.7	146.6	153.2	145.2	135.9	128.8	138.0	130.8	136.7	129.6	66.5
7.5D	17.5	86.5	90.8	87.8	92.2	87.0	91.3	77.2	81.0	78.4	82.3	77.6	81.5	37.7
7.5D	22.5	42.0	42.8	42.6	43.4	42.2	43.0	37.4	38.2	38.0	38.8	37.7	38.4	17.7
7.5D	27.5	16.0	16.4	16.2	16.7	16.1	16.5	14.2	14.6	14.5	14.9	14.3	14.7	6.9
12.5D	2.5	194.2	189.8	197.2	192.7	195.4	190.9	173.3	169.4	176.0	172.0	174.4	170.4	80.1
12.5D	7.5	152.1	151.1	154.5	153.4	153.0	152.0	135.8	134.8	137.9	136.9	136.5	135.6	66.5
12.5D	12.5	94.7	94.4	96.2	95.9	95.3	94.9	84.5	84.2	85.8	85.5	85.0	84.7	45.7
12.5D	17.5	49.8	48.0	50.6	48.8	50.1	48.3	44.4	42.9	45.1	43.5	44.7	43.1	26.1
12.5D	22.5	22.5	21.7	22.8	22.0	22.6	21.8	20.1	19.4	20.4	19.7	20.2	19.5	12.4
17.5D	2.5	135.6	137.5	137.7	139.6	136.4	138.3	121.0	122.7	122.9	124.6	121.7	123.4	45.3
17.5D	7.5	94.0	97.6	95.4	99.1	94.5	98.1	83.9	87.1	85.2	88.4	84.4	87.6	37.7
17.5D	12.5	52.4	51.7	53.3	52.5	52.7	52.0	46.8	46.2	47.5	46.9	47.1	46.4	26.1
17.5D	17.5	23.6	23.8	24.0	24.2	23.8	24.0	21.1	21.3	21.4	21.6	21.2	21.4	15.0
17.5D	22.5	11.3	12.0	11.5	12.1	11.4	12.0	10.1	10.7	10.3	10.8	10.2	10.7	7.2
22.5D	2.5	63.2	63.4	64.2	64.3	63.6	63.7	56.4	56.6	57.3	57.4	56.8	56.9	21.2
22.5D	7.5	44.6	44.3	45.3	45.0	44.9	44.6	39.8	39.5	40.4	40.1	40.0	39.8	17.7
22.5D	12.5	24.2	23.4	24.6	23.7	24.3	23.5	21.6	20.8	21.9	21.2	21.7	21.0	12.4
22.5D	17.5	12.2	11.9	12.4	12.1	12.3	11.9	10.9	10.6	11.0	10.8	10.9	10.7	7.2
27.5D	2.5	27.9	28.3	28.3	28.8	28.0	28.5	24.9	25.3	25.2	25.7	25.0	25.4	8.2
27.5D	7.5	20.6	20.7	21.0	21.1	20.8	20.9	18.4	18.5	18.7	18.8	18.5	18.6	6.9

Luminous Intensity 6.4.4.1 through 6.4.4.4

Sample	CRT1610241001-001-005					Target Input voltage		Measured Input Voltage		0, 0 Lum. Intensity		Vac Variation Factor		MMLI Factor	
Module	12" Omni Arrow					80Vac		80.3 Vac		261.8 Candela		1.002		0.865	
Color:	Yellow					120Vac		120.1 Vac		261.4 Candela		1.000		5/35 Factor	
Lens	Tinted					135Vac		135.1 Vac		262.0 Candela		1.002		1.033	
Photometric Test Distance: 25 meters															
Max. cd	436.8	25°C		25°C		25°C		74°C/49°C		74°C/49°C		74°C/49°C			
Vertical	Horizontal	Rated 80Vac		Measured 120Vac		Rated 135Vac		Rated 80Vac		Measured 120Vac		Rated 135Vac		Table 3	
Angle	Angle	Candela	Candela	Candela	Candela	Candela	Candela	Candela	Candela	Candela	Candela	Candela	Candela	Candela	Minimum
Up/Down	Left/Right	Left	Right	Left	Right	Left	Right	Left	Right	Left	Right	Left	Right	Left	Candela
27.5U	7.5	21.7	21.8	21.7	21.8	21.8	21.9	18.8	18.9	18.8	18.9	18.8	18.9	18.9	6.9
27.5U	2.5	26.2	26.2	26.1	26.1	26.2	26.2	22.6	22.6	22.6	22.6	22.6	22.6	22.7	8.2
22.5U	17.5	15.5	17.9	15.5	17.8	15.5	17.9	13.4	15.5	13.4	15.4	13.4	15.5	15.5	7.2
22.5U	12.5	24.8	26.2	24.8	26.2	24.9	26.2	21.5	22.7	21.5	22.6	21.5	22.7	22.7	12.4
22.5U	7.5	39.7	39.6	39.7	39.5	39.8	39.6	34.4	34.3	34.3	34.2	34.4	34.3	34.3	17.7
22.5U	2.5	52.1	51.5	52.0	51.4	52.1	51.5	45.0	44.6	45.0	44.5	45.1	44.6	44.6	21.2
17.5U	22.5	15.8	18.3	15.8	18.3	15.8	18.3	13.7	15.8	13.7	15.8	13.7	15.8	15.8	7.2
17.5U	17.5	26.2	29.2	26.1	29.2	26.2	29.2	22.6	25.3	22.6	25.2	22.6	25.3	25.3	15.0
17.5U	12.5	49.2	51.9	49.2	51.8	49.3	52.0	42.6	44.9	42.5	44.8	42.6	44.9	44.9	26.1
17.5U	7.5	84.8	83.1	84.7	82.9	84.9	83.1	73.3	71.9	73.2	71.7	73.4	71.9	71.9	37.7
17.5U	2.5	112.8	110.4	112.6	110.3	112.9	110.5	97.6	95.5	97.4	95.4	97.7	95.6	95.6	45.3
12.5U	22.5	24.0	28.9	24.0	28.9	24.1	28.9	20.8	25.0	20.8	25.0	20.8	25.0	25.0	12.4
12.5U	17.5	48.0	54.5	47.9	54.4	48.0	54.5	41.5	47.1	41.5	47.0	41.6	47.1	47.1	26.1
12.5U	12.5	88.5	95.8	88.3	95.6	88.5	95.9	76.5	82.9	76.4	82.7	76.6	82.9	82.9	45.7
12.5U	7.5	145.4	139.1	145.2	138.9	145.5	139.2	125.8	120.3	125.6	120.1	125.9	120.4	120.4	66.5
12.5U	2.5	187.7	178.4	187.5	178.2	187.9	178.6	162.4	154.3	162.1	154.1	162.5	154.5	154.5	80.1
7.5U	27.5	17.6	22.1	17.6	22.1	17.6	22.2	15.2	19.2	15.2	19.1	15.2	19.2	19.2	6.9
7.5U	22.5	38.1	48.3	38.0	48.2	38.1	48.3	33.0	41.8	32.9	41.7	33.0	41.8	41.8	17.7
7.5U	17.5	77.0	92.5	76.9	92.4	77.0	92.6	66.6	80.0	66.5	79.9	66.6	80.1	80.1	37.7
7.5U	12.5	141.6	144.2	141.4	143.9	141.7	144.3	122.5	124.7	122.3	124.5	122.6	124.8	124.8	66.5
7.5U	7.5	211.9	200.7	211.5	200.4	212.0	200.8	183.3	173.6	183.0	173.3	183.4	173.7	173.7	97.0
7.5U	2.5	243.7	242.6	243.4	242.2	243.9	242.8	210.8	209.8	210.5	209.5	211.0	210.0	210.0	117.1
2.5U	27.5	21.4	29.1	21.4	29.1	21.4	29.2	18.5	25.2	18.5	25.2	18.5	25.2	25.2	8.2
2.5U	22.5	53.1	65.0	53.1	64.9	53.2	65.1	46.0	56.2	45.9	56.1	46.0	56.3	56.3	21.2
2.5U	17.5	112.4	124.0	112.2	123.8	112.5	124.1	97.2	107.2	97.1	107.1	97.3	107.3	107.3	45.3
2.5U	12.5	184.9	189.7	184.7	189.4	185.1	189.9	160.0	164.1	159.7	163.8	160.1	164.2	164.2	80.1
2.5U	7.5	238.7	242.6	238.3	242.2	238.8	242.8	206.4	209.8	206.1	209.5	206.6	210.0	210.0	117.1
2.5U	2.5	260.4	268.6	260.0	268.2	260.6	268.8	225.2	232.3	224.9	232.0	225.4	232.5	232.5	141.6
2.5D	2.5	268.6	266.2	268.2	265.8	268.8	266.4	232.3	230.3	232.0	229.9	232.5	230.4	230.4	141.6
2.5D	7.5	244.6	235.8	244.2	235.4	244.7	235.9	211.5	203.9	211.2	203.6	211.7	204.1	204.1	117.1
2.5D	12.5	197.6	189.2	197.3	188.9	197.7	189.3	170.9	163.6	170.6	163.4	171.0	163.8	163.8	80.1
2.5D	17.5	127.4	129.3	127.2	129.1	127.5	129.4	110.2	111.8	110.0	111.6	110.3	111.9	111.9	45.3
2.5D	22.5	60.8	61.6	60.7	61.5	60.8	61.7	52.6	53.3	52.5	53.2	52.6	53.3	53.3	21.2
2.5D	27.5	23.0	25.1	22.9	25.1	23.0	25.1	19.9	21.7	19.8	21.7	19.9	21.7	21.7	8.2
7.5D	2.5	248.2	251.3	247.8	250.9	248.4	251.5	214.7	217.4	214.4	217.0	214.8	217.5	217.5	117.1
7.5D	7.5	224.3	218.9	223.9	218.6	224.4	219.1	194.0	189.3	193.7	189.1	194.1	189.5	189.5	97.0
7.5D	12.5	162.8	157.1	162.6	156.9	162.9	157.2	140.8	135.9	140.6	135.7	140.9	136.0	136.0	66.5
7.5D	17.5	90.8	93.8	90.6	93.7	90.8	93.9	78.5	81.2	78.4	81.0	78.6	81.2	81.2	37.7
7.5D	22.5	42.3	42.8	42.3	42.7	42.4	42.8	36.6	37.0	36.6	36.9	36.7	37.0	37.0	17.7
7.5D	27.5	15.7	15.7	15.7	15.7	15.7	15.8	13.6	13.6	13.6	13.6	13.6	13.6	13.6	6.9
12.5D	2.5	203.3	207.4	203.0	207.1	203.4	207.6	175.8	179.4	175.6	179.1	176.0	179.5	179.5	80.1
12.5D	7.5	156.9	166.7	156.7	166.5	157.0	166.9	135.7	144.2	135.5	144.0	135.8	144.3	144.3	66.5
12.5D	12.5	99.0	103.2	98.8	103.1	99.0	103.3	85.6	89.3	85.5	89.2	85.7	89.4	89.4	45.7
12.5D	17.5	53.1	52.2	53.0	52.1	53.1	52.2	45.9	45.1	45.8	45.1	45.9	45.2	45.2	26.1
12.5D	22.5	23.6	22.4	23.6	22.4	23.7	22.4	20.4	19.4	20.4	19.4	20.5	19.4	19.4	12.4
17.5D	2.5	140.7	148.1	140.4	147.9	140.8	148.2	121.7	128.1	121.5	127.9	121.8	128.2	128.2	45.3
17.5D	7.5	95.1	106.3	94.9	106.1	95.1	106.4	82.2	91.9	82.1	91.8	82.3	92.0	92.0	37.7
17.5D	12.5	53.2	59.6	53.2	59.5	53.3	59.6	46.1	51.5	46.0	51.5	46.1	51.6	51.6	26.1
17.5D	17.5	24.5	26.0	24.5	25.9	24.6	26.0	21.2	22.5	21.2	22.4	21.2	22.5	22.5	15.0
17.5D	22.5	11.4	12.0	11.4	12.0	11.4	12.0	9.9	10.4	9.9	10.3	9.9	10.4	10.4	7.2
22.5D	2.5	66.1	70.6	66.0	70.5	66.2	70.6	57.2	61.0	57.1	60.9	57.2	61.1	61.1	21.2
22.5D	7.5	45.6	48.8	45.5	48.7	45.6	48.8	39.4	42.2	39.4	42.1	39.4	42.2	42.2	17.7
22.5D	12.5	24.1	26.0	24.1	25.9	24.1	26.0	20.9	22.5	20.8	22.4	20.9	22.5	22.5	12.4
22.5D	17.5	11.7	12.3	11.7	12.3	11.7	12.3	10.1	10.7	10.1	10.7	10.1	10.7	10.7	7.2
27.5D	2.5	28.5	30.2	28.4	30.2	28.5	30.2	24.6	26.1	24.6	26.1	24.7	26.2	26.2	8.2
27.5D	7.5	20.1	22.5	20.0	22.5	20.1	22.5	17.4	19.5	17.3	19.5	17.4	19.5	19.5	6.9

Luminous Intensity 6.4.4.1 through 6.4.4.4

Sample	CRT1610241001-002-002				Target Input voltage		Measured Input Voltage				0, 0 Lum. Intensity		Vac Variation Factor		MMLI Factor	
Module	12" Omni Arrow				80Vac		80.3		Vac		243.3 Candela		0.987		0.880	
Color:	Yellow				120Vac		120.4		Vac		246.4 Candela		1.000		5/35 Factor	
Lens	Tinted				135Vac		135.2		Vac		245.2 Candela		0.995		1.050	
Photometric Test Distance: 25 meters																
Max. cd	436.8	25°C		25°C		25°C		74°C/49°C		74°C/49°C		74°C/49°C				
Vertical	Horizontal	Rated 80Vac		Measured 120Vac		Rated 135Vac		Rated 80Vac		Measured 120Vac		Rated 135Vac		Table 3		
Angle	Angle	Candela	Candela	Candela	Candela	Candela	Candela	Candela	Candela	Candela	Candela	Candela	Candela	Candela	Minimum	
Up/Down	Left/Right	Left	Right	Left	Right	Left	Right	Left	Right	Left	Right	Left	Right	Left	Right	Candela
27.5U	7.5	24.3	21.3	24.6	21.5	24.5	21.4	21.4	18.7	21.6	19.0	21.5	18.9	6.9		
27.5U	2.5	28.0	27.1	28.3	27.5	28.2	27.3	24.6	23.9	24.9	24.2	24.8	24.1	8.2		
22.5U	17.5	17.2	17.5	17.5	17.7	17.4	17.6	15.2	15.4	15.4	15.6	15.3	15.5	7.2		
22.5U	12.5	28.2	25.8	28.5	26.1	28.4	26.0	24.8	22.7	25.1	23.0	25.0	22.9	12.4		
22.5U	7.5	44.3	39.2	44.9	39.7	44.7	39.6	39.0	34.5	39.5	35.0	39.3	34.8	17.7		
22.5U	2.5	56.0	53.4	56.7	54.1	56.4	53.8	49.3	47.0	49.9	47.6	49.7	47.4	21.2		
17.5U	22.5	16.9	18.0	17.2	18.2	17.1	18.2	14.9	15.9	15.1	16.1	15.0	16.0	7.2		
17.5U	17.5	28.4	29.4	28.7	29.8	28.6	29.6	25.0	25.9	25.3	26.2	25.2	26.1	15.0		
17.5U	12.5	53.7	51.6	54.4	52.3	54.1	52.0	47.2	45.4	47.8	46.0	47.6	45.8	26.1		
17.5U	7.5	90.3	82.1	91.5	83.2	91.0	82.8	79.5	72.3	80.5	73.2	80.1	72.9	37.7		
17.5U	2.5	116.0	107.7	117.5	109.1	116.9	108.6	102.1	94.8	103.4	96.0	102.9	95.6	45.3		
12.5U	22.5	25.5	30.8	25.8	31.2	25.7	31.0	22.5	27.1	22.8	27.5	22.6	27.3	12.4		
12.5U	17.5	50.4	57.3	51.0	58.1	50.7	57.8	44.3	50.5	44.9	51.1	44.7	50.9	26.1		
12.5U	12.5	96.4	99.5	97.6	100.7	97.1	100.2	84.8	87.6	85.9	88.7	85.5	88.2	45.7		
12.5U	7.5	159.2	147.0	161.2	148.9	160.4	148.2	140.1	129.4	141.9	131.1	141.2	130.4	66.5		
12.5U	2.5	195.2	185.2	197.6	187.6	196.7	186.6	171.8	163.0	174.0	165.1	173.1	164.3	80.1		
7.5U	27.5	18.9	23.5	19.1	23.8	19.0	23.6	16.6	20.7	16.8	20.9	16.8	20.8	6.9		
7.5U	22.5	39.6	50.3	40.1	51.0	39.9	50.7	34.8	44.3	35.3	44.9	35.1	44.7	17.7		
7.5U	17.5	79.8	101.5	80.9	102.8	80.5	102.3	70.3	89.4	71.2	90.5	70.8	90.1	37.7		
7.5U	12.5	149.3	156.3	151.2	158.3	150.5	157.5	131.4	137.6	133.1	139.3	132.5	138.6	66.5		
7.5U	7.5	219.7	211.3	222.5	214.0	221.4	213.0	193.4	186.0	195.9	188.4	194.9	187.5	97.0		
7.5U	2.5	249.5	257.1	252.7	260.3	251.4	259.1	219.6	226.3	222.4	229.2	221.3	228.1	117.1		
2.5U	27.5	22.5	28.8	22.8	29.2	22.7	29.0	19.8	25.3	20.1	25.7	20.0	25.5	8.2		
2.5U	22.5	54.3	66.8	55.0	67.6	54.8	67.3	47.8	58.8	48.4	59.5	48.2	59.3	21.2		
2.5U	17.5	111.9	131.9	113.3	133.6	112.8	132.9	98.5	116.1	99.7	117.6	99.3	117.0	45.3		
2.5U	12.5	187.9	194.8	190.3	197.3	189.4	196.4	165.4	171.5	167.5	173.7	166.7	172.9	80.1		
2.5U	7.5	248.9	246.1	252.0	249.2	250.8	248.0	219.1	216.6	221.9	219.4	220.8	218.3	117.1		
2.5U	2.5	274.9	274.2	278.4	277.7	277.0	276.3	242.0	241.3	245.1	244.4	243.9	243.2	141.6		
2.5D	2.5	283.8	272.2	287.4	275.7	286.0	274.3	249.8	239.6	253.0	242.7	251.8	241.5	141.6		
2.5D	7.5	257.1	244.1	260.3	247.2	259.1	246.0	226.3	214.9	229.2	217.6	228.1	216.6	117.1		
2.5D	12.5	208.3	198.6	211.0	201.1	209.9	200.1	183.4	174.8	185.7	177.0	184.8	176.2	80.1		
2.5D	17.5	133.1	133.3	134.8	135.0	134.2	134.4	117.2	117.4	118.7	118.9	118.1	118.3	45.3		
2.5D	22.5	64.5	64.1	65.3	64.9	65.0	64.6	56.8	56.4	57.5	57.1	57.2	56.9	21.2		
2.5D	27.5	25.1	24.0	25.4	24.3	25.3	24.2	22.1	21.2	22.4	21.4	22.2	21.3	8.2		
7.5D	2.5	256.6	256.0	259.9	259.3	258.6	258.0	225.9	225.4	228.8	228.2	227.7	227.1	117.1		
7.5D	7.5	230.7	222.5	233.7	225.4	232.5	224.3	203.1	195.9	205.7	198.4	204.7	197.4	97.0		
7.5D	12.5	171.4	161.5	173.6	163.5	172.7	162.7	150.9	142.1	152.8	143.9	152.1	143.2	66.5		
7.5D	17.5	98.3	94.2	99.6	95.4	99.1	95.0	86.6	82.9	87.7	84.0	87.2	83.6	37.7		
7.5D	22.5	46.3	41.6	46.9	42.1	46.7	41.9	40.8	36.6	41.3	37.1	41.1	36.9	17.7		
7.5D	27.5	18.5	15.4	18.7	15.6	18.6	15.5	16.3	13.6	16.5	13.7	16.4	13.7	6.9		
12.5D	2.5	210.2	213.5	212.9	216.2	211.8	215.2	185.0	187.9	187.4	190.3	186.5	189.4	80.1		
12.5D	7.5	162.3	175.6	164.3	177.8	163.5	176.9	142.9	154.5	144.7	156.5	144.0	155.7	66.5		
12.5D	12.5	106.2	110.4	107.5	111.8	107.0	111.3	93.5	97.2	94.7	98.5	94.2	98.0	45.7		
12.5D	17.5	58.0	55.5	58.8	56.2	58.5	55.9	51.1	48.9	51.7	49.5	51.5	49.2	26.1		
12.5D	22.5	27.1	24.1	27.4	24.4	27.3	24.3	23.8	21.3	24.1	21.5	24.0	21.4	12.4		
17.5D	2.5	140.2	155.1	142.0	157.1	141.3	156.3	123.4	136.6	125.0	138.3	124.4	137.6	45.3		
17.5D	7.5	97.2	115.1	98.4	116.6	97.9	116.0	85.5	101.3	86.6	102.6	86.2	102.1	37.7		
17.5D	12.5	56.2	65.8	56.9	66.7	56.6	66.3	49.4	58.0	50.1	58.7	49.8	58.4	26.1		
17.5D	17.5	27.3	29.5	27.7	29.9	27.5	29.7	24.1	26.0	24.4	26.3	24.2	26.2	15.0		
17.5D	22.5	13.1	13.2	13.3	13.4	13.2	13.3	11.6	11.6	11.7	11.8	11.7	11.7	7.2		
22.5D	2.5	65.7	76.6	66.6	77.6	66.3	77.2	57.9	67.4	58.6	68.3	58.3	67.9	21.2		
22.5D	7.5	45.0	56.1	45.5	56.8	45.3	56.5	39.6	49.4	40.1	50.0	39.9	49.8	17.7		
22.5D	12.5	24.9	32.2	25.2	32.6	25.1	32.5	21.9	28.4	22.2	28.7	22.1	28.6	12.4		
22.5D	17.5	12.7	15.5	12.9	15.7	12.8	15.6	11.2	13.7	11.3	13.8	11.3	13.8	7.2		
27.5D	2.5	29.3	33.3	29.7	33.8	29.6	33.6	25.8	29.3	26.2	29.7	26.0	29.6	8.2		
27.5D	7.5	20.2	27.4	20.4	27.8	20.3	27.6	17.8	24.1	18.0	24.5	17.9	24.3	6.9		

Luminous Intensity 6.4.4.1 through 6.4.4.4

Sample	CRT1611071057-003-002			Target Input voltage		Measured Input Voltage		0, 0 Lum. Intensity		Vac Variation Factor		MMLI Factor			
Module	12" Omni Arrow			80Vac		80.4 Vac		267.1 Candela		0.991		0.892			
Color:	Yellow			120Vac		120.1 Vac		269.4 Candela		1.000		5/35 Factor			
Lens	Clear			135Vac		135.2 Vac		271.0 Candela		1.006		1.036			
Photometric Test Distance: 25 meters															
Max. cd	436.8		25°C		25°C		25°C		74°C/49°C		74°C/49°C		74°C/49°C		
Vertical	Horizontal		Rated 80Vac		Measured 120Vac		Rated 135Vac		Rated 80Vac		Measured 120Vac		Rated 135Vac		Table 3
Angle	Angle	Candela	Candela	Candela	Candela	Candela	Candela	Candela	Candela	Candela	Candela	Candela	Candela	Candela	Minimum
Up/Down	Left/Right	Left	Right	Left	Right	Left	Right	Left	Right	Left	Right	Left	Right	Left	Right
27.5U	7.5	23.3	23.3	23.5	23.5	23.6	23.6	20.8	20.8	21.0	21.0	21.1	21.1	6.9	
27.5U	2.5	28.4	28.9	28.6	29.2	28.8	29.3	25.3	25.8	25.5	26.0	25.7	26.2	8.2	
22.5U	17.5	15.8	18.1	15.9	18.2	16.0	18.3	14.1	16.1	14.2	16.3	14.3	16.4	7.2	
22.5U	12.5	25.7	26.1	25.9	26.4	26.0	26.5	22.9	23.3	23.1	23.5	23.2	23.7	12.4	
22.5U	7.5	41.6	41.7	41.9	42.0	42.2	42.3	37.1	37.2	37.4	37.5	37.6	37.7	17.7	
22.5U	2.5	55.6	56.3	56.1	56.8	56.4	57.1	49.6	50.3	50.1	50.7	50.4	51.0	21.2	
17.5U	22.5	15.6	18.0	15.7	18.2	15.8	18.3	13.9	16.1	14.0	16.2	14.1	16.3	7.2	
17.5U	17.5	25.7	27.8	25.9	28.1	26.1	28.2	22.9	24.8	23.1	25.0	23.3	25.2	15.0	
17.5U	12.5	47.7	49.8	48.1	50.2	48.4	50.5	42.6	44.4	42.9	44.8	43.2	45.1	26.1	
17.5U	7.5	84.7	83.8	85.4	84.5	85.9	85.0	75.5	74.7	76.2	75.4	76.6	75.8	37.7	
17.5U	2.5	116.7	114.1	117.7	115.1	118.4	115.8	104.1	101.8	105.0	102.7	105.7	103.3	45.3	
12.5U	22.5	23.0	27.1	23.1	27.3	23.3	27.5	20.5	24.2	20.7	24.4	20.8	24.5	12.4	
12.5U	17.5	44.6	50.7	45.0	51.2	45.2	51.5	39.8	45.3	40.1	45.7	40.4	45.9	26.1	
12.5U	12.5	89.3	95.8	90.1	96.6	90.6	97.2	79.7	85.5	80.4	86.2	80.9	86.7	45.7	
12.5U	7.5	152.1	146.6	153.5	147.9	154.4	148.7	135.8	130.8	136.9	131.9	137.7	132.7	66.5	
12.5U	2.5	199.1	189.7	200.8	191.4	202.0	192.5	177.6	169.3	179.2	170.8	180.2	171.8	80.1	
7.5U	27.5	16.8	21.0	17.0	21.2	17.1	21.3	15.0	18.7	15.1	18.9	15.2	19.0	6.9	
7.5U	22.5	37.4	46.4	37.7	46.8	37.9	47.1	33.3	41.4	33.6	41.8	33.8	42.0	17.7	
7.5U	17.5	77.8	94.0	78.5	94.9	78.9	95.4	69.4	83.9	70.0	84.6	70.4	85.1	37.7	
7.5U	12.5	147.0	151.0	148.3	152.3	149.2	153.2	131.2	134.7	132.3	135.9	133.1	136.7	66.5	
7.5U	7.5	222.0	210.6	223.9	212.4	225.2	213.7	198.1	187.9	199.8	189.5	201.0	190.7	97.0	
7.5U	2.5	251.4	245.6	253.6	247.7	255.1	249.2	224.3	219.2	226.2	221.1	227.6	222.4	117.1	
2.5U	27.5	20.7	28.0	20.8	28.2	21.0	28.4	18.4	24.9	18.6	25.2	18.7	25.3	8.2	
2.5U	22.5	53.3	65.6	53.7	66.2	54.0	66.6	47.5	58.5	47.9	59.0	48.2	59.4	21.2	
2.5U	17.5	116.1	127.1	117.1	128.2	117.8	128.9	103.6	113.4	104.5	114.4	105.1	115.0	45.3	
2.5U	12.5	193.3	195.9	195.0	197.6	196.2	198.8	172.5	174.8	174.0	176.3	175.0	177.4	80.1	
2.5U	7.5	248.7	243.8	250.9	245.9	252.3	247.3	221.9	217.5	223.8	219.4	225.2	220.7	117.1	
2.5U	2.5	274.6	269.9	277.0	272.2	278.6	273.8	245.0	240.8	247.1	242.9	248.6	244.3	141.6	
2.5D	2.5	282.6	274.1	285.1	276.5	286.7	278.1	252.2	244.6	254.3	246.7	255.9	248.1	141.6	
2.5D	7.5	252.8	242.9	255.0	245.0	256.5	246.4	225.6	216.7	227.5	218.6	228.9	219.9	117.1	
2.5D	12.5	203.5	200.2	205.3	201.9	206.5	203.1	181.6	178.7	183.2	180.2	184.2	181.3	80.1	
2.5D	17.5	131.8	141.2	132.9	142.4	133.7	143.2	117.6	125.9	118.6	127.0	119.3	127.8	45.3	
2.5D	22.5	61.9	69.0	62.4	69.6	62.8	70.0	55.2	61.6	55.7	62.1	56.0	62.5	21.2	
2.5D	27.5	22.9	26.6	23.1	26.8	23.3	27.0	20.5	23.7	20.6	23.9	20.8	24.1	8.2	
7.5D	2.5	256.5	261.5	258.7	263.7	260.3	265.3	228.9	233.3	230.9	235.3	232.2	236.7	117.1	
7.5D	7.5	228.5	223.6	230.4	225.6	231.8	226.9	203.9	199.6	205.6	201.3	206.8	202.5	97.0	
7.5D	12.5	166.1	163.2	167.5	164.6	168.5	165.6	148.2	145.7	149.5	146.9	150.4	147.8	66.5	
7.5D	17.5	94.2	97.2	95.0	98.0	95.6	98.6	84.0	86.7	84.8	87.4	85.3	88.0	37.7	
7.5D	22.5	44.4	45.1	44.8	45.5	45.1	45.8	39.6	40.3	40.0	40.6	40.2	40.8	17.7	
7.5D	27.5	16.4	17.4	16.6	17.5	16.7	17.6	14.6	15.5	14.8	15.7	14.9	15.7	6.9	
12.5D	2.5	212.2	217.0	214.1	218.8	215.3	220.1	189.4	193.6	191.0	195.3	192.1	196.4	80.1	
12.5D	7.5	162.2	176.3	163.6	177.8	164.6	178.9	144.7	157.3	146.0	158.7	146.9	159.6	66.5	
12.5D	12.5	100.5	108.9	101.3	109.8	101.9	110.5	89.6	97.2	90.4	98.0	90.9	98.6	45.7	
12.5D	17.5	51.7	52.8	52.1	53.3	52.4	53.6	46.1	47.2	46.5	47.6	46.8	47.8	26.1	
12.5D	22.5	23.2	24.4	23.4	24.6	23.6	24.7	20.7	21.8	20.9	21.9	21.0	22.1	12.4	
17.5D	2.5	142.8	153.0	144.0	154.3	144.9	155.2	127.4	136.5	128.5	137.7	129.3	138.5	45.3	
17.5D	7.5	95.7	109.2	96.5	110.1	97.1	110.8	85.4	97.4	86.1	98.3	86.7	98.9	37.7	
17.5D	12.5	51.6	58.7	52.0	59.2	52.3	59.5	46.0	52.4	46.4	52.8	46.7	53.1	26.1	
17.5D	17.5	23.6	26.6	23.8	26.8	23.9	27.0	21.1	23.7	21.2	23.9	21.4	24.1	15.0	
17.5D	22.5	11.6	13.1	11.7	13.2	11.8	13.3	10.3	11.7	10.4	11.8	10.5	11.9	7.2	
22.5D	2.5	65.0	70.8	65.5	71.4	65.9	71.8	58.0	63.2	58.5	63.7	58.8	64.1	21.2	
22.5D	7.5	44.6	50.4	45.0	50.8	45.3	51.1	39.8	45.0	40.2	45.3	40.4	45.6	17.7	
22.5D	12.5	23.2	26.9	23.4	27.1	23.6	27.3	20.7	24.0	20.9	24.2	21.0	24.3	12.4	
22.5D	17.5	11.7	13.4	11.8	13.6	11.9	13.6	10.5	12.0	10.6	12.1	10.6	12.2	7.2	
27.5D	2.5	26.7	29.0	26.9	29.3	27.1	29.5	23.8	25.9	24.0	26.1	24.1	26.3	8.2	
27.5D	7.5	19.2	22.1	19.4	22.3	19.5	22.4	17.2	19.7	17.3	19.9	17.4	20.0	6.9	

Luminous Intensity 6.4.4.1 through 6.4.4.4

Sample	CRT1611071057-003-003	Target input voltage	Measured Input Voltage	0, 0 Lum. Intensity	Vac Variation Factor	MMLI Factor
Module	12" Omni Arrow	80Vac	80.2 Vac	267.9 Candela	0.989	0.895
Color:	Yellow	120Vac	120.4 Vac	270.8 Candela	1.000	5/35 Factor
Lens	Clear	135Vac	135.5 Vac	272.2 Candela	1.005	1.035

Photometric Test Distance: 25 meters

Max. cd	436.8	25°C		25°C		25°C		74°C/49°C		74°C/49°C		74°C/49°C		
Vertical	Horizontal	Rated 80Vac	Measured 120Vac	Rated 135Vac	Measured 120Vac	Rated 80Vac	Measured 120Vac	Rated 80Vac	Measured 120Vac	Rated 135Vac	Measured 120Vac	Rated 135Vac	Measured 120Vac	Table 3
Angle	Angle	Candela	Candela	Candela	Candela	Candela	Candela	Candela	Candela	Candela	Candela	Candela	Candela	Minimum
Up/Down	Left/Right	Left	Right	Left	Right	Left	Right	Left	Right	Left	Right	Left	Right	Candela
27.5U	7.5	23.2	23.2	23.5	23.5	23.6	23.6	20.8	20.8	21.0	21.0	21.1	21.1	6.9
27.5U	2.5	28.3	28.8	28.6	29.1	28.7	29.3	25.3	25.8	25.6	26.1	25.7	26.2	8.2
22.5U	17.5	15.7	18.0	15.9	18.2	16.0	18.3	14.1	16.1	14.2	16.3	14.3	16.4	7.2
22.5U	12.5	25.6	26.1	25.9	26.3	26.0	26.5	22.9	23.3	23.1	23.6	23.3	23.7	12.4
22.5U	7.5	41.5	41.5	41.9	42.0	42.1	42.2	37.1	37.2	37.5	37.6	37.7	37.8	17.7
22.5U	2.5	55.5	56.2	56.1	56.8	56.4	57.1	49.6	50.2	50.2	50.8	50.4	51.1	21.2
17.5U	22.5	15.5	18.0	15.7	18.2	15.8	18.3	13.9	16.1	14.0	16.2	14.1	16.3	7.2
17.5U	17.5	25.6	27.7	25.9	28.0	26.0	28.2	22.9	24.8	23.2	25.1	23.3	25.2	15.0
17.5U	12.5	47.6	49.6	48.1	50.2	48.3	50.4	42.6	44.4	43.0	44.9	43.2	45.1	26.1
17.5U	7.5	84.4	83.5	85.3	84.4	85.8	84.9	75.5	74.7	76.3	75.5	76.7	75.9	37.7
17.5U	2.5	116.4	113.8	117.6	115.0	118.2	115.6	104.1	101.8	105.2	102.9	105.8	103.5	45.3
12.5U	22.5	22.9	27.0	23.1	27.3	23.3	27.4	20.5	24.2	20.7	24.4	20.8	24.6	12.4
12.5U	17.5	44.4	50.6	44.9	51.1	45.2	51.4	39.8	45.3	40.2	45.7	40.4	46.0	26.1
12.5U	12.5	89.1	95.5	90.0	96.6	90.5	97.1	79.7	85.5	80.5	86.4	81.0	86.8	45.7
12.5U	7.5	151.7	146.2	153.3	147.8	154.1	148.5	135.7	130.8	137.2	132.2	137.9	132.9	66.5
12.5U	2.5	198.5	189.2	200.7	191.2	201.7	192.2	177.6	169.3	179.5	171.1	180.5	172.0	80.1
7.5U	27.5	16.8	20.9	17.0	21.2	17.0	21.3	15.0	18.7	15.2	18.9	15.2	19.0	6.9
7.5U	22.5	37.3	46.3	37.7	46.8	37.9	47.0	33.3	41.4	33.7	41.8	33.9	42.1	17.7
7.5U	17.5	77.6	93.8	78.4	94.8	78.8	95.3	69.4	83.9	70.2	84.8	70.5	85.2	37.7
7.5U	12.5	146.6	150.6	148.2	152.2	148.9	153.0	131.2	134.7	132.6	136.2	133.3	136.9	66.5
7.5U	7.5	221.4	210.0	223.8	212.3	224.9	213.4	198.1	187.9	200.2	189.9	201.2	190.9	97.0
7.5U	2.5	250.7	244.9	253.4	247.6	254.7	248.9	224.3	219.1	226.7	221.5	227.9	222.7	117.1
2.5U	27.5	20.6	27.9	20.8	28.2	20.9	28.3	18.4	24.9	18.6	25.2	18.7	25.3	8.2
2.5U	22.5	53.1	65.4	53.7	66.1	54.0	66.5	47.5	58.5	48.0	59.2	48.3	59.5	21.2
2.5U	17.5	115.8	126.7	117.0	128.1	117.6	128.7	103.6	113.4	104.7	114.6	105.2	115.2	45.3
2.5U	12.5	192.8	195.3	194.9	197.5	195.9	198.5	172.5	174.8	174.4	176.7	175.3	177.6	80.1
2.5U	7.5	248.0	243.1	250.7	245.7	252.0	247.0	221.9	217.5	224.3	219.8	225.5	221.0	117.1
2.5U	2.5	273.8	269.1	276.8	272.0	278.2	273.4	245.0	240.8	247.6	243.4	248.9	244.6	141.6
2.5D	2.5	281.8	273.3	284.8	276.3	286.3	277.7	252.1	244.5	254.9	247.2	256.2	248.5	141.6
2.5D	7.5	252.1	242.2	254.8	244.8	256.1	246.0	225.6	216.7	228.0	219.0	229.2	220.1	117.1
2.5D	12.5	202.9	199.6	205.1	201.8	206.2	202.8	181.6	178.6	183.5	180.6	184.5	181.5	80.1
2.5D	17.5	131.4	140.7	132.8	142.3	133.5	143.0	117.6	125.9	118.9	127.3	119.5	128.0	45.3
2.5D	22.5	61.7	68.8	62.4	69.6	62.7	69.9	55.2	61.6	55.8	62.2	56.1	62.6	21.2
2.5D	27.5	22.9	26.5	23.1	26.8	23.2	26.9	20.5	23.7	20.7	24.0	20.8	24.1	8.2
7.5D	2.5	255.8	260.7	258.5	263.5	259.9	264.9	228.9	233.3	231.3	235.8	232.5	237.0	117.1
7.5D	7.5	227.8	223.0	230.3	225.4	231.5	226.6	203.8	199.5	206.0	201.7	207.1	202.7	97.0
7.5D	12.5	165.6	162.8	167.4	164.5	168.3	165.4	148.2	145.6	149.8	147.2	150.6	148.0	66.5
7.5D	17.5	93.9	96.9	94.9	97.9	95.4	98.4	84.0	86.7	84.9	87.6	85.4	88.1	37.7
7.5D	22.5	44.3	45.0	44.8	45.5	45.0	45.7	39.6	40.2	40.1	40.7	40.3	40.9	17.7
7.5D	27.5	16.4	17.3	16.5	17.5	16.6	17.6	14.6	15.5	14.8	15.7	14.9	15.8	6.9
12.5D	2.5	211.6	216.3	213.9	218.7	215.0	219.8	189.4	193.6	191.4	195.7	192.4	196.7	80.1
12.5D	7.5	161.7	175.8	163.5	177.7	164.3	178.6	144.7	157.3	146.3	159.0	147.0	159.8	66.5
12.5D	12.5	100.2	108.6	101.2	109.8	101.8	110.3	89.6	97.2	90.6	98.2	91.1	98.7	45.7
12.5D	17.5	51.5	52.7	52.1	53.3	52.3	53.5	46.1	47.1	46.6	47.7	46.8	47.9	26.1
12.5D	22.5	23.2	24.3	23.4	24.6	23.6	24.7	20.7	21.8	21.0	22.0	21.1	22.1	12.4
17.5D	2.5	142.4	152.5	143.9	154.2	144.7	155.0	127.4	136.5	128.8	137.9	129.4	138.7	45.3
17.5D	7.5	95.4	108.9	96.5	110.1	97.0	110.6	85.4	97.4	86.3	98.5	86.8	99.0	37.7
17.5D	12.5	51.4	58.5	52.0	59.2	52.3	59.5	46.0	52.4	46.5	52.9	46.8	53.2	26.1
17.5D	17.5	23.5	26.5	23.8	26.8	23.9	26.9	21.1	23.7	21.3	24.0	21.4	24.1	15.0
17.5D	22.5	11.6	13.1	11.7	13.2	11.8	13.3	10.3	11.7	10.5	11.8	10.5	11.9	7.2
22.5D	2.5	64.8	70.6	65.5	71.4	65.8	71.7	58.0	63.2	58.6	63.9	58.9	64.2	21.2
22.5D	7.5	44.5	50.2	45.0	50.8	45.2	51.0	39.8	44.9	40.3	45.4	40.5	45.7	17.7
22.5D	12.5	23.2	26.8	23.4	27.1	23.5	27.2	20.7	24.0	20.9	24.2	21.1	24.4	12.4
22.5D	17.5	11.7	13.4	11.8	13.6	11.9	13.6	10.5	12.0	10.6	12.1	10.6	12.2	7.2
27.5D	2.5	26.6	29.0	26.9	29.3	27.0	29.4	23.8	25.9	24.1	26.2	24.2	26.3	8.2
27.5D	7.5	19.2	22.0	19.4	22.3	19.5	22.4	17.2	19.7	17.4	19.9	17.4	20.0	6.9

Luminous Intensity 6.4.4.1 through 6.4.4.4

Sample	CRT1611071057-003-004				Target input voltage		Measured Input Voltage				0,0 Lum. Intensity		Vac Variation Factor		MMLI Factor					
Module	12" Omni Arrow				80Vac		80.2		Vac		303.4 Candela		0.992		0.855					
Color:	Yellow				120Vac		120.1		Vac		306.0 Candela		1.000		5/35 Factor					
Lens	Clear				135Vac		135.2		Vac		304.2 Candela		0.994		1.079					
Photometric Test Distance: 25 meters																				
Max. cd	436.8	25°C				25°C				25°C				74°C/49°C		74°C/49°C		74°C/49°C		
Vertical	Horizontal	Rated 80Vac		Measured 120Vac		Rated 135Vac		Rated 80Vac		Measured 120Vac		Rated 135Vac		Table 3						
Angle	Angle	Candela	Candela	Candela	Candela	Candela	Candela	Candela	Candela	Candela	Candela	Candela	Candela	Candela	Minimum					
Up/Down	Left/Right	Left	Right	Left	Right	Left	Right	Left	Right	Left	Right	Left	Right	Left	Right	Candela				
27.5U	7.5	23.6	24.9	23.8	25.1	23.7	25.0	20.2	21.3	20.4	21.5	20.3	21.4			6.9				
27.5U	2.5	29.9	29.9	30.1	30.1	29.9	30.0	25.5	25.5	25.7	25.8	25.6	25.6			8.2				
22.5U	17.5	17.3	18.8	17.4	19.0	17.3	18.9	14.8	16.1	14.9	16.2	14.8	16.1			7.2				
22.5U	12.5	28.1	29.5	28.4	29.7	28.2	29.6	24.1	25.2	24.3	25.4	24.1	25.3			12.4				
22.5U	7.5	45.4	47.2	45.8	47.6	45.5	47.3	38.8	40.3	39.1	40.7	38.9	40.4			17.7				
22.5U	2.5	62.5	62.0	63.0	62.6	62.7	62.2	53.5	53.1	53.9	53.5	53.6	53.2			21.2				
17.5U	22.5	18.4	18.8	18.5	18.9	18.4	18.8	15.7	16.1	15.8	16.2	15.7	16.1			7.2				
17.5U	17.5	31.0	31.8	31.3	32.0	31.1	31.9	26.5	27.2	26.8	27.4	26.6	27.2			15.0				
17.5U	12.5	57.4	59.3	57.9	59.8	57.6	59.5	49.1	50.8	49.5	51.2	49.2	50.9			26.1				
17.5U	7.5	102.1	101.5	103.0	102.4	102.4	101.8	87.4	86.8	88.1	87.6	87.6	87.1			37.7				
17.5U	2.5	138.5	133.3	139.7	134.4	138.9	133.6	118.5	114.0	119.5	115.0	118.8	114.3			45.3				
12.5U	22.5	28.7	29.6	28.9	29.9	28.8	29.7	24.5	25.3	24.7	25.5	24.6	25.4			12.4				
12.5U	17.5	59.1	61.3	59.6	61.9	59.3	61.5	50.6	52.5	51.0	52.9	50.7	52.6			26.1				
12.5U	12.5	109.3	111.0	110.2	112.0	109.6	111.3	93.5	95.0	94.3	95.8	93.7	95.2			45.7				
12.5U	7.5	176.3	168.5	177.8	169.9	176.7	168.9	150.8	144.1	152.0	145.3	151.2	144.5			66.5				
12.5U	2.5	234.3	218.8	236.4	220.7	235.0	219.4	200.4	187.2	202.1	188.8	201.0	187.7			80.1				
7.5U	27.5	20.3	22.7	20.5	22.8	20.4	22.7	17.4	19.4	17.5	19.5	17.4	19.4			6.9				
7.5U	22.5	46.5	52.3	46.9	52.7	46.7	52.4	39.8	44.7	40.2	45.1	39.9	44.8			17.7				
7.5U	17.5	95.5	106.4	96.3	107.4	95.7	106.7	81.6	91.0	82.3	91.8	81.9	91.3			37.7				
7.5U	12.5	173.1	172.7	174.5	174.2	173.5	173.2	148.0	147.7	149.3	149.0	148.4	148.1			66.5				
7.5U	7.5	255.4	250.5	257.6	252.6	256.1	251.2	218.4	214.2	220.3	216.1	219.0	214.8			97.0				
7.5U	2.5	298.6	297.3	301.2	299.9	299.4	298.1	255.4	254.3	257.6	256.5	256.1	255.0			117.1				
2.5U	27.5	24.7	30.9	24.9	31.1	24.7	30.9	21.1	26.4	21.3	26.6	21.2	26.5			8.2				
2.5U	22.5	63.4	73.9	63.9	74.5	63.6	74.1	54.2	63.2	54.7	63.8	54.4	63.4			21.2				
2.5U	17.5	134.9	144.8	136.0	146.1	135.2	145.2	115.4	123.9	116.3	124.9	115.7	124.2			45.3				
2.5U	12.5	219.8	224.1	221.7	226.0	220.4	224.7	188.0	191.6	189.6	193.3	188.5	192.1			80.1				
2.5U	7.5	289.8	290.4	292.2	292.9	290.5	291.2	247.8	248.4	249.9	250.5	248.5	249.0			117.1				
2.5U	2.5	322.6	317.6	325.4	320.3	323.4	318.4	275.9	271.6	278.3	273.9	276.6	272.3			141.6				
2.5D	2.5	332.6	315.2	335.5	317.9	333.5	316.0	284.5	269.6	286.9	271.9	285.2	270.3			141.6				
2.5D	7.5	303.7	286.9	306.3	289.3	304.5	287.6	259.7	245.3	261.9	247.4	260.4	246.0			117.1				
2.5D	12.5	242.4	235.1	244.4	237.1	243.0	235.7	207.3	201.1	209.1	202.8	207.8	201.6			80.1				
2.5D	17.5	148.6	160.1	149.8	161.5	149.0	160.5	127.1	136.9	128.2	138.1	127.4	137.3			45.3				
2.5D	22.5	67.7	76.9	68.3	77.5	67.9	77.1	57.9	65.7	58.4	66.3	58.1	65.9			21.2				
2.5D	27.5	25.0	29.1	25.3	29.3	25.1	29.1	21.4	24.9	21.6	25.1	21.5	24.9			8.2				
7.5D	2.5	299.7	302.2	302.3	304.8	300.5	303.0	256.3	258.4	258.5	260.6	257.0	259.1			117.1				
7.5D	7.5	265.5	263.5	267.7	265.8	266.2	264.2	227.0	225.4	229.0	227.3	227.6	226.0			97.0				
7.5D	12.5	188.4	189.7	190.0	191.4	188.9	190.2	161.1	162.3	162.5	163.7	161.5	162.7			66.5				
7.5D	17.5	102.1	114.0	103.0	115.0	102.4	114.3	87.3	97.5	88.1	98.3	87.6	97.8			37.7				
7.5D	22.5	46.0	53.2	46.4	53.7	46.1	53.4	39.4	45.5	39.7	45.9	39.5	45.6			17.7				
7.5D	27.5	16.3	18.8	16.5	18.9	16.4	18.8	14.0	16.0	14.1	16.2	14.0	16.1			6.9				
12.5D	2.5	246.1	242.6	248.2	244.7	246.8	243.2	210.5	207.5	212.3	209.2	211.0	208.0			80.1				
12.5D	7.5	188.1	193.8	189.8	195.5	188.6	194.3	160.9	165.8	162.3	167.2	161.3	166.2			66.5				
12.5D	12.5	117.9	123.4	118.9	124.5	118.2	123.8	100.8	105.6	101.7	106.5	101.1	105.8			45.7				
12.5D	17.5	62.3	63.8	62.8	64.4	62.4	64.0	53.2	54.6	53.7	55.1	53.4	54.7			26.1				
12.5D	22.5	25.4	28.1	25.6	28.3	25.4	28.1	21.7	24.0	21.9	24.2	21.8	24.1			12.4				
17.5D	2.5	168.8	167.6	170.2	169.0	169.2	168.0	144.4	143.3	145.6	144.6	144.7	143.7			45.3				
17.5D	7.5	114.0	120.3	115.0	121.4	114.3	120.6	97.5	102.9	98.3	103.8	97.8	103.2			37.7				
17.5D	12.5	65.1	70.0	65.7	70.6	65.3	70.2	55.7	59.8	56.2	60.4	55.8	60.0			26.1				
17.5D	17.5	29.1	31.5	29.4	31.7	29.2	31.6	24.9	26.9	25.1	27.1	25.0	27.0			15.0				
17.5D	22.5	12.3	14.6	12.4	14.7	12.3	14.6	10.5	12.5	10.6	12.6	10.5	12.5			7.2				
22.5D	2.5	79.4	81.4	80.1	82.1	79.6	81.6	67.9	69.6	68.5	70.2	68.1	69.8			21.2				
22.5D	7.5	53.5	56.7	54.0	57.2	53.7	56.8	45.8	48.5	46.2	48.9	45.9	48.6			17.7				
22.5D	12.5	27.4	29.7	27.6	29.9	27.5	29.7	23.4	25.4	23.6	25.6	23.5	25.4			12.4				
22.5D	17.5	13.6	13.5	13.7	13.6	13.6	13.5	11.6	11.5	11.7	11.6	11.6	11.6			7.2				
27.5D	2.5	32.3	32.4	32.6	32.7	32.4	32.5	27.7	27.7	27.9	27.9	27.7	27.8			8.2				
27.5D	7.5	22.4	23.5	22.6	23.7	22.5	23.5	19.2	20.1	19.3	20.2	19.2	20.1			6.9				

Complies: ☒ YES ☐ NO

Tested By:	Matthew Benninger	Signature or initials:	mb	Comp. Date:	12/16/2016,12/18/2016
Reviewed By:	cwm	Signature or initials:	<i>cwm</i>		
Test Equipment Used:	15,16,17,18				
Amb (°C):	25	RH%:	27		

Lens Abrasion Resistance 6.4.5.2

A lens was mounted in the abrasion test fixture with the lens facing upwards. An abrading pad was cycled back and forth (1 cycle) for twelve cycles at $10\text{cm} \pm 2\text{cm}$ per second over the test surface of the lens. The abrading pad shall not be less than $2.5\text{cm} \pm 0.1\text{cm}$ square, constructed of 0000 steel wool rubber cemented to a rigid base shaped to the contour of the lens. The "grain" of the pad was perpendicular to the direction of motion. The abrading pad support was equal in size to the pad and the center of the support surface was within $\pm 2\text{mm}$ of parallel to the lens surface. The density of the abrading pad was such that when the pad was mounted to its support and is resting unweight on the lens, the base of the pad was no closer than 3.2mm to the lens at its closest point. When mounted on its support and resting on the lens, the abrading pad was weighted such that a pad pressure of $14\text{kPa} \pm 1\text{kPa}$ exists at the center and perpendicular to the face of the lens. A pivot was used to follow the contour of the lens.

Results

A single intensity point was measured before and after the abrasion. In all samples tested the abraded lens intensity measurement was at least 90% of the un-abraded lens intensity measurement.

12" Yellow Omni Arrow Tinted			
Sample	Pre Abrasion	Post Abrasion	Percentage
CRT1610241001-001-004	241.9	238.2	98.5
CRT1610241001-001-005	261.4	259.1	99.1
CRT1610241001-002-002	246.4	246.1	99.9

measurements in cd

12" Yellow Omni Arrow Clear			
Sample	Pre Abrasion	Post Abrasion	Percentage
CRT1611071057-003-002	269.4	266.8	99.0
CRT1611071057-003-003	270.8	261.9	96.7
CRT1611071057-003-004	306.0	304.2	99.4

measurements in cd

Measured Voltage:	120.2	Vac		
Measured Weight:	11	lbs		
Abrasion Pad	5.5	Sq. In		
Pad Pressure	2.0	psi	13.8	Kpa

Complies: ☒ YES ☐ NO

Tested By:	Matthew Benninger	Signature or initials:	mb	Comp. Date	12/20/16
Reviewed By:	cwm	Signature or initials:	<i>AM</i>		
Test Equipment Used:	15,16,17,18,19				
Amb (°C):	23	RH%	28		

Luminance Uniformity

Luminance measurements were taken at nine locations across the signal face. A spot size of 1/2 inch was used. The luminance meter was translated from side to side and up and down remaining normal to the sample surface. The measurements were used to determine luminance uniformity. The measurements were taken after operating on the same duty cycle used during the photometric test.

Results

The ratio between the maximum and the minimum luminance was less than 10 to 1. Data follows.

12" Yellow Omni Arrow Tinted			
Sample	CRT1610241001-001-004	CRT1610241001-001-005	CRT1610241001-002-002
Location	Luminance	Luminance	Luminance
1	1392	1509	1213
2	1637	1875	1726
3	1677	1791	1639
4	1461	1563	1574
5	1127	1310	953
6	940	1048	1067
7	1405	1547	1541
8	1657	1834	1943
9	1256	1415	1222
Average	1395	1544	1431
Intensity Ratio	1.8 to 1.0	1.8 to 1.0	2.0 to 1.0

Note: Neutral density filter 1.0 was used for luminance measurements and are relative.

12" Yellow Omni Arrow Clear			
Sample	CRT1611071057-003-002	CRT1611071057-003-003	CRT1611071057-003-004
Location	Luminance	Luminance	Luminance
1	1015	1261	1121
2	1929	1606	1947
3	1693	1708	1801
4	1783	1993	2246
5	1023	1253	1040
6	1083	1100	1076
7	1541	1625	2324
8	1899	2241	2725
9	1314	1371	1488
Average	1476	1573	1752
Intensity Ratio	1.9 to 1.0	2.0 to 1.0	2.6 to 1.0

Note: Neutral density filter 1.0 was used for luminance measurements and are relative.

Luminance measurements are in cd/m²

Same 60 minute warm-up used for luminous intensity

Test distance is 9.5 feet with ¼ degree aperture using the PR 740

Measured Voltage:	119.9 - 120.1	Vac
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Complies: ☒ YES ☐ NO

Tested By:	Kurt Dobler	Signature or initials:	kfd	Comp. Date	11/11/16
Reviewed By:	cwm	Signature or initials:	<i>cwm</i>		
Test Equipment Used:	1,3,10,11				
Amb (°C):	22.1	RH%	27		

Chromaticity 6.4.4.6

The chromaticity measurements were performed on the submitted LED Traffic Signal Modules with the spectroradiometer. The samples were operated at nominal input voltage and ambient temperature during the measurements. The measurements were taken from 380-780nm in 2nm increments.

The chromaticity measurements were taken at nine locations across the signal face. A spot size of 1/2 inch was used with the samples operating on the same duty cycle used during the photometric test. The spectroradiometer was translated from side to side and up and down remaining normal to the sample surface. The average of the measurements are recorded.

Results



12" Omni Arrow		Chromaticity Coordinates	
Color	Sample	x	y
Green (Tinted)	CRT1610241001-001-004	0.576	0.421
	CRT1610241001-001-005	0.573	0.425
	CRT1610241001-002-002	0.578	0.420

12" Omni Arrow		Chromaticity Coordinates	
Color	Sample	x	y
Green (Clear)	CRT1611071057-003-002	0.558	0.436
	CRT1611071057-003-003	0.561	0.434
	CRT1611071057-003-004	0.559	0.436

The chromaticity measurements pass the requirements of the referenced specification.

Measured Voltage:	119.9 - 120.1	Vac
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Complies: ☒ YES ☐ NO

Tested By:	Kurt Dobler/John Robins	Signature or initials:	kfd 	Comp. Date	11/17/16
Reviewed By:	cwm	Signature or initials:			
Test Equipment Used:	1,3,10,11				
Amb (°C):	23.3	RH%	28		

Color Uniformity 6.4.4.7

Three samples of each model were tested. Nine color measurements were taken at different locations on the traffic signal face. The measurements were taken after operating on the same duty cycle used during the photometric test. The dominant wave length was found using the measured (x, y) coordinates and table 3.29 of "Color Science" by Wyszecki & Stiles.

Results

12" Yellow Omni Arrow Tinted									
Sample	CRT1610241001-001-004			CRT1610241001-001-005			CRT1610241001-002-002		
Location	x	y	Dominant	x	y	Dominant	x	y	Dominant
1	0.577	0.421	590	0.571	0.426	590	0.576	0.422	590
2	0.577	0.421	590	0.574	0.424	590	0.579	0.340	591
3	0.576	0.422	590	0.572	0.426	590	0.577	0.420	591
4	0.577	0.421	590	0.573	0.424	590	0.578	0.420	591
5	0.577	0.421	590	0.573	0.424	590	0.579	0.419	591
6	0.575	0.422	590	0.573	0.425	590	0.577	0.421	590
7	0.575	0.423	590	0.573	0.425	590	0.577	0.421	591
8	0.575	0.423	590	0.572	0.425	590	0.578	0.420	591
9	0.579	0.419	591	0.573	0.425	590	0.579	0.419	591
Average	0.576	0.421	590	0.573	0.425	590	0.578	0.411	591

12" Yellow Omni Arrow Clear									
Sample	CRT1611071057-003-002			CRT1611071057-003-003			CRT1611071057-003-004		
Location	x	y	Dominant	x	y	Dominant	x	y	Dominant
1	0.558	0.436	588	0.562	0.433	589	0.558	0.436	588
2	0.561	0.434	588	0.563	0.432	589	0.560	0.435	588
3	0.558	0.437	588	0.559	0.436	588	0.559	0.436	588
4	0.559	0.436	588	0.560	0.435	588	0.558	0.435	588
5	0.559	0.436	588	0.563	0.432	589	0.560	0.435	588
6	0.557	0.437	588	0.560	0.434	588	0.559	0.435	588
7	0.556	0.437	588	0.559	0.436	588	0.559	0.435	588
8	0.558	0.436	588	0.560	0.435	588	0.557	0.437	588
9	0.557	0.438	588	0.563	0.432	589	0.556	0.439	588
Average	0.558	0.436	588	0.561	0.434	588	0.559	0.436	588

Measured Voltage:	119.9 - 120.1	Vac
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Complies:	<input checked="" type="checkbox"/> YES	<input type="checkbox"/> NO
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Tested By:	Kurt Dobler/John Robins	Signature or initials:	kfd <i>Y</i>	Comp. Date	11/17/16
Reviewed By:	cwm	Signature or initials:	<i>cwm</i>	Comp. Date	12/13/16
Test Equipment Used:	1,3,10,11				
Amb (°C):	23.3	RH%	28		

Current Consumption 6.4.6.1

Three samples were measured for current flow in amperes. The measured current values are supplied for comparison of Product Quality Assurance current measurements on production modules. Current measurements were taken at start up.

Results

Measurements are in (mA)

12" Yellow Omni Arrow			
Sample	-40°C	25°C	74°C
CRT1610241001-001-001	103.8	89.0	84.3
CRT1610241001-001-002	103.3	89.7	85.1
CRT1610241001-001-003	102.1	89.6	85.1

The current consumption was not in excess of 120% of the label current values for an ambient temperature of 25°C.

Measured Voltage:	120.1	Vac
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Complies: ☒ YES ☐ NO

Tested By:	John Robins	Signature or initials:	<i>JR</i>	Comp. Date	11/10/16
Reviewed By:	cwm	Signature or initials:	<i>cwm</i>		
Test Equipment Used:	2,8				
Amb (°C):	na	RH%	na		

Low Voltage Turn Off 6.4.6.2

Three samples were measured to ensure compliance with the low voltage turn-off requirement. Each sample was fully illuminated at the nominal operating voltage. The applied voltage was then reduced to the point where there was no visible illumination.

Results

There was no visible illumination when the applied voltage was less than 35Vac RMS.

12" Yellow Omni Arrow	
Sample	Low Voltage Turn Off (Vac RMS)
CRT1610241001-001-001	65.1
CRT1610241001-001-002	63.9
CRT1610241001-001-003	64.2

Complies: ☒ YES ☐ NO

Tested By:	Kurt Dobler	Signature or initials:	kfd	Comp. Date	11/9/16
Reviewed By:	cwm	Signature or initials:	<i>cwm</i>		
Test Equipment Used:	1,9				
Amb (°f):	72	RH%	37		

Turn-On/Turn-Off Times 6.4.6.3

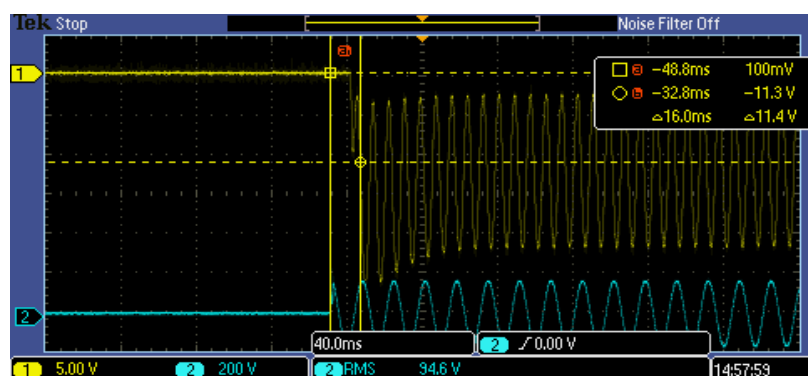
Three samples were measured to ensure compliance with the turn-on and turn-off requirements. The measurements were conducted using a two channel oscilloscope to measure the time delay between when the samples are energized at 120 Vac RMS and when the light output reaches 90% of full output. The same test equipment was used to measure the time delay between when the sample is de-energized and when the light output reaches 0% of full output.

Results

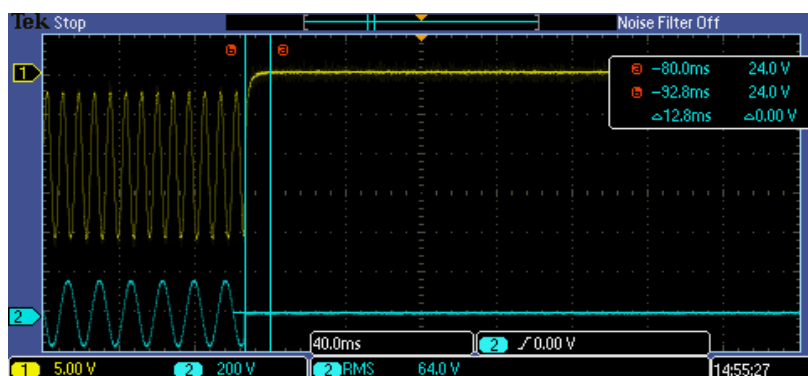
12" Yellow Omni Arrow		
Sample	Turn On	Turn Off
CRT1610241001-001-001	16.0	12.8
CRT1610241001-001-002	14.4	10.4
CRT1610241001-001-003	14.4	10.4

The "on" time and "off" time were within the 75ms requirement on all samples tested.

Sample Turn On Time



Sample Turn Off Time



Measured Voltage: 135 Vac

Complies: ☒ YES ☐ NO

Tested By:	John Robins	Signature or initials:	<i>JR</i>	Comp. Date:	12/6/16
Reviewed By:	cwm	Signature or initials:	<i>cwm</i>		
Test Equipment Used:	9,13,14				
Amb (°f):	72	RH%	28		

Transient Voltage Immunity 6.4.6.4

Three samples were subjected to 3 positive and 3 negative 1000V 7.5 joule pulses across their input leads at a rate of 0.5 pps in accordance with NEMA TS 2-2003 section 2.1.8. The pulses were the discharge from a 15µF capacitor. The devices were then energized with rated voltage to verify proper operation.

Results

The signal modules withstood the applications of the transient voltage without damage or operational deterioration.

12" Yellow Omni Arrow			
Sample	3 Positive Pulses	3 Negative Pulses	Results
CRT1610241001-001-001	x	x	Pass
CRT1610241001-001-002	x	x	Pass
CRT1610241001-001-003	x	x	Pass

Measured Voltage:	1000	Vdc
Measured Capacitance:	15.8 - 16.6	µF

Complies: ☒ YES ☐ NO

Tested By:	Kurt Dobler	Signature or initials:	kfd	Comp. Date	12/8/16
Reviewed By:	cwm	Signature or initials:	<i>[Signature]</i>		
Test Equipment Used:	1,9				
Amb (°f):	72	RH%	30		

Electronic Noise 6.4.6.5

Three LED traffic signal modules were operated at 120 VAC/60Hz throughout the test. Emissions measurements were taken to compare values to applicable requirements.

Results

The emissions complied with the requirements of the referenced specification. The testing was performed at our Oakdale, MN office. See report: 102785964MIN-014Y

Complies: ☒ YES ☐ NO

Tested By:	Randy Libersky	Signature or initials:	See Report	Comp. Date	12/27/16
Reviewed By:	Norman Shpilsher	Signature or initials:	See Report		
Test Equipment Used:	See Report				
Amb (°C):	See Report	RH%	See Report		

Power Factor & Total Harmonic Distortion 6.4.6.6 & 6.4.6.7



Three tinted samples of each model were measured for power factor and total harmonic distortion. A commercially available power analyzer was used to perform these measurements.

Results

12" Yellow Omni Arrow						
Sample	Voltage	Current (mA)	Power (W)	Power Factor	THD V%	THD I%
CRT1610241001-001-001	120.1	88.5	10.3	0.97	0.81	14.3
CRT1610241001-001-002	120.0	89.4	10.4	0.97	0.84	15.1
CRT1610241001-001-003	120.0	89.3	10.4	0.97	0.81	15.6
Requirement	NA	NA	NA	≥ 0.90	≤ 20%	≤ 20%

Measurements taken after a minimum 60 minute warmup.

Complies: ☒ YES ☐ NO

Tested By:	John Robins	Signature or initials:		Comp. Date	11/9/16
Reviewed By:	cwm	Signature or initials:			
Test Equipment Used:	8,9				
Amb (°f):	74	RH%	27		

Load Switch Compatibility 6.4.7.1

Three samples were connected to a variable AC voltage supply. The sample was monitored for sufficient current draw to ensure proper load switch operation while the voltage is varied from 80V rms to 135 V rms.

Results

The load switch data is provided to the client to determine if the current draw is acceptable. The referenced ITE specification does not list a minimum current draw requirement. As a result, the Caltrans Standard Specifications dated 2010, Section 86-4.01D(2)(a) must be followed listing a minimum power consumption requirement of 5 watts for 12" traffic signal modules.

12" Yellow Omni Arrow		
Sample	80 Vrms	135 Vrms
CRT1610241001-001-001	125.8	82.7
CRT1610241001-001-002	127.4	83.3
CRT1610241001-001-003	127.4	83.3

Current measurements are in mA

12" Yellow Omni Arrow		
Sample	80 Vrms	135 Vrms
CRT1610241001-001-001	9.6	10.2
CRT1610241001-001-002	9.7	10.4
CRT1610241001-001-003	9.7	10.4

Power measurements are in watts.

Measured Voltage 80Vac:	80.1	Vac
Measured Voltage 135Vac:	134.9	Vac

Complies: ☒ YES ☐ NO

Tested By:	John Robins	Signature or initials:	<i>JR</i>	Comp. Date	11/9/16
Reviewed By:	cwm	Signature or initials:	<i>cwm</i>		
Test Equipment Used:	8,9				
Amb (°C):	70	RH%	38		

Off State Voltage Decay 6.4.7.2

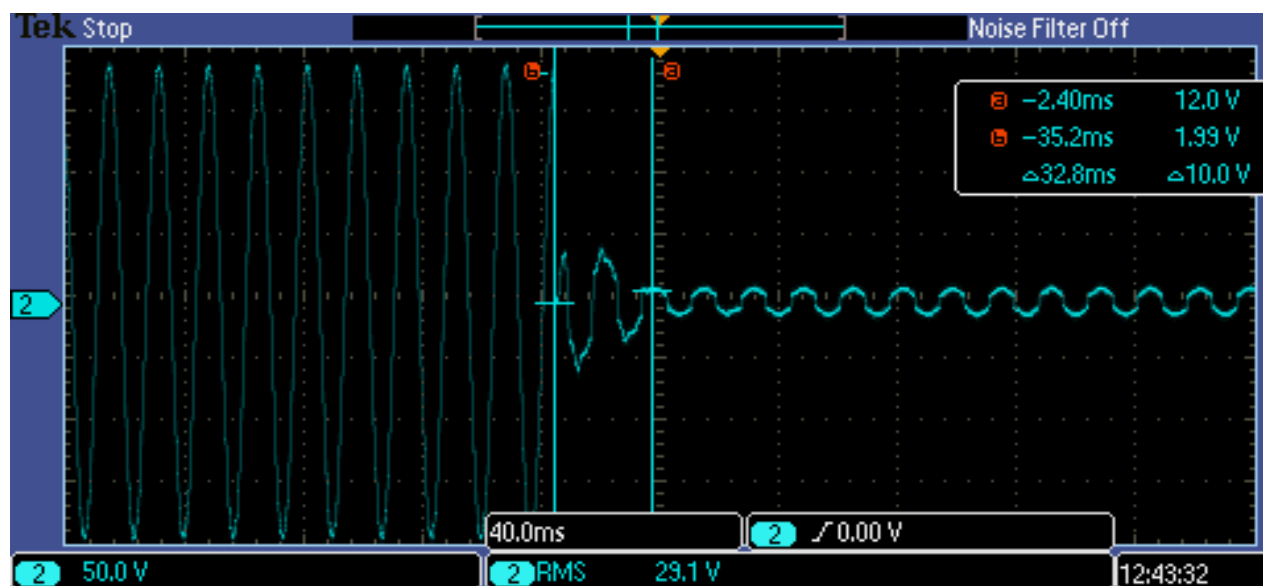
Three samples were operated from a 135V AC voltage supply. A 19.5 k-ohm resistor was wired in series in the hot line between the LED signal monitor and the AC power supply. A single-pole-single-throw switch was wired in parallel across the 19.5 k-ohm resistor. A 220 k-ohm shunt resistor was wired between the hot line connection and the neutral line connection on the LED signal module. The single-pole-single-throw switch was closed, shorting out the 19.5 k-ohm resistor, allowing the AC power supply to illuminate the LED signal module. Next the switch was opened and the voltage across the 220 k-ohm shunt resistor was measured for a decay to a value equal to or less than 10V rms within a time period equal to or less than 100 milliseconds. The test was repeated a sufficient number of times to ensure testing occurs at the peak of the AC line voltage cycle.

Results

12" Yellow Omni Arrow	
sample	Decay Time (mS)
CRT1610241001-001-001	32.0
CRT1610241001-001-002	32.8
CRT1610241001-001-003	31.2

In all samples measured the decay time was less than 100mS.

Sample Screen Shot



Measured Voltage: 135 Vac

Complies: ☒ YES ☐ NO

Tested By:	John Robins	Signature or initials:	<i>JR</i>	Comp. Date	6/7/16
Reviewed By:	cwm	Signature or initials:	<i>cwm</i>		
Test Equipment Used:	9,13,14				
Amb (°f):	72	RH%	29		

Failed State Impedance 6.4.8

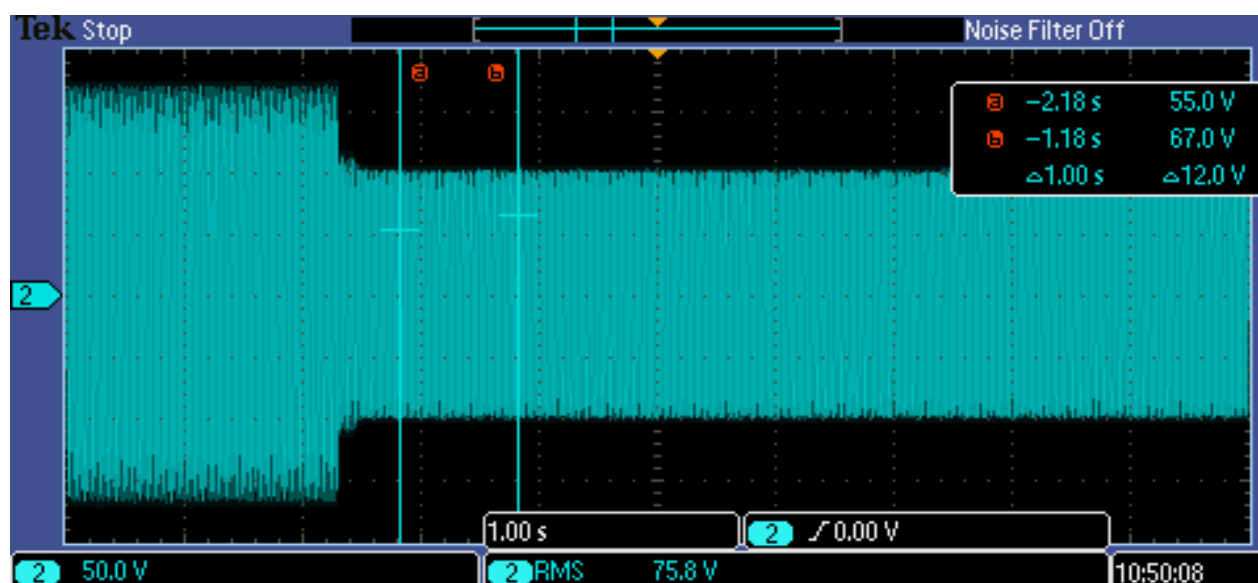
First the LED board is disconnected from the signal power supply. Then the LED signal modules are operated from a 120V AC voltage supply. A 50k-ohm resistor is wired in series in the hot line between the LED signal module and the AC power supply. A single-pole-single-throw switch is wired in parallel across the 50k-ohm resistor. A 100 k-ohm shunt resistor is wired between the hot line connection and the neutral line connection on the LED signal module. The single-pole-single-throw switch is opened and the voltage across the 100 k-ohm shunt resistor is measured from 500mS through 1500mS, after energizing the circuit with the open switch. The test was repeated 10 times.

Results

12" Yellow Omni Arrow	
sample	Vrms
CRT1610241001-001-001	75.8
CRT1610241001-001-002	75.8
CRT1610241001-001-003	75.9

In all samples tested the voltage across the 100KΩ resistor was greater than 70 Vac RMS.

Sample Screen Shot



Measured Voltage: 120 Vac

Complies: ☒ YES ☐ NO

Tested By:	John Robins	Signature or initials:		Comp. Date	1/27/17
Reviewed By:	cwm	Signature or initials:	<i>cwm</i>		
Test Equipment Used:	9,13,14				
Amb (°f):	72	RH%	28		

Equipment list				
#	Intertek ID No.	Description	Manufacturer	Calibration Due
1	M207	multimeter	fluke	17-Aug-2017
2	H204	chamber	thermotron	10-Nov-2017
3	T1486	Digit Hygro-Thermometer	Extech	16-Mar-2017
4	V272	Signal Conditioner	Unholtz-Dickie	27-Jun-2017
5	V393	Vibration Controler	Unholtz-Dickie	15-Jul-2017
6	V328	Accelerometer	PCB Piezotronics	02-Dec-2016
7	V334	Accelerometer	PCB Piezotronics	18-Feb-2017
8	G032S	Power Analyzer	Yokogawa	09-May-2017
9	T835	Temp/Humidity	Supco	10-Jun-2017
10	O757	Spectra Scan	Photo Research	23-Mar-2017
11	R153	Distance Meter	Leica	7-Dec-2016
12	O719	flexOptometer	UDT	03-Dec-2016
13	V244	High Voltage Probe	Tektronix	03-Nov-2017
14	E470	Oscilloscope	Tektronix	08-Jul-2017
15	O109	Goniometer	Optroniks	03-Oct-2017
16	O114	5M Photometer	Optroniks	24-Oct-2017
17	T1555	Hygro-Thermometer	Extech	03-May-2017
18	M135	multimeter	Fluke	04-Apr-2017
19	S159	Push-Pull Scale	Controls International	07-Jan-2017
20	N1153	Rain Gauge	Cole-Parmer	06-Jan-2019
21	N1419	Stopwatch	Control Co	16-Aug-2017
22	T804	Thermometer	Fluke	16-May-2017
23	Y205	Anemometer	Omega	23-May-2017
Note: For measurement uncertainty, refer to the calibration certificates for all the test equipment located in the equipment files				



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Issue Date: February 27, 2017
Project No. G102472631
Quote No.: Qu-00673375

Contact: Hamid Kashani
Email: hamid@leotek.com
Phone No. 408-380-1788

Report No. 102472631CRT-001Y

Leotek Electronics USA LLC

1955 Lundy Ave
San Jose, CA 95131

Standards

Performance Specification of the Institute of Transportation Engineers, Vehicle Traffic Control Signal Heads: Light Emitting Diode (LED) Circular Signal Supplement, dated June 27, 2005.

Standard Specifications Caltrans dated 2010. Section 86-4.01D(2)(a)

<i>Test Purpose</i>	ITE Testing of Models; TSL-12Y-LX-IL6-A1-P2 & TSL-12Y-LX-IL6-A1-P2-CLR
<i>Test Dates</i>	November 1, 2016 through February 27, 2017

John C. Robins
Engineer
Lighting

Jeremy N. Downs, P.E.
Staff Engineer
Lighting

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Test Plan and Datasheets			
Client	Leotek Electronics USA LLC	Engineer	John C. Robins
Report #	102472631CRT-001Y	Reviewer	Christopher W. Metcalf
Product	12" Yellow Ball Tinted & Clear	Model(s)	TSL-12Y-LX-IL6-A1-P2 & P2-CLR
Standard	ITE, Circular Signal Supplement, dated June 27, 2005.		

Spec	Test name	Clause	Pass Fail NA
ITE	Conditioning	6.4.2	Pass
ITE	Mechanical Vibration	6.4.3.1	Pass
ITE	Temperature Cycling	6.4.3.2	Pass
ITE	Moisture Resistance	6.4.3.3	Pass
ITE	Luminous Intensity	6.4.4.1, 2,3,4	Pass
ITE	Luminance Uniformity	6.4.4.5	Pass
ITE	Chromaticity	6.4.4.6	Pass
ITE	Color Uniformity	6.4.4.7	Pass
ITE	Lens Abrasion Resistance	6.4.5.2	Pass
ITE	Current Consumption	6.4.6.1	Pass
ITE	Low Voltage Turn Off	6.4.6.2	Pass
ITE	Turn-On/Turn-Off Times	6.4.6.3	Pass
ITE	Transient Voltage Immunity	6.4.6.4	Pass
ITE	Electronic Noise	6.4.6.5	Pass
ITE	Power Factor & Total Harmonic Distortion	6.4.6.6, 7	Pass
ITE	Load Switch Compatibility	6.4.7.1	Pass
ITE	Off State Voltage Decay	6.4.7.2	Pass
ITE	Failed State Impedance	6.4.8	Pass

Sample Information				
Date Rec.	Package ID	Description	Condition	Model No.
10/24/2016	CRT1610241001-004	12" yellow tinted ball	production	TSL-12Y-LX-IL6-A1-P2
10/24/2016	CRT1610241001-008	12" yellow tinted ball	production	TSL-12Y-LX-IL6-A1-P2
11/7/2016	CRT1611071057-004	12" yellow clear ball	production	TSL-12Y-LX-IL6-A1-P2-CLR

Further Sample Description

Intertek Sample Number	Description	Model Number	Serial Number
CRT1610241001-004-001	12" yellow tinted ball	TSL-12Y-LX-IL6-A1-P2	16917515
CRT1610241001-004-002	12" yellow tinted ball	TSL-12Y-LX-IL6-A1-P2	16917516
CRT1610241001-004-003	12" yellow tinted ball	TSL-12Y-LX-IL6-A1-P2	16917517
CRT1610241001-004-004	12" yellow tinted ball	TSL-12Y-LX-IL6-A1-P2	16917518
CRT1610241001-004-005	12" yellow tinted ball	TSL-12Y-LX-IL6-A1-P2	16917519
CRT1610241001-008-003	12" yellow tinted ball	TSL-12Y-LX-IL6-A1-P2	16917520
CRT1611071057-004-001	12" yellow clear ball	TSL-12Y-LX-IL6-A1-P2-CLR	T16B004
CRT1611071057-004-002	12" yellow clear ball	TSL-12Y-LX-IL6-A1-P2-CLR	T16B005
CRT1611071057-004-003	12" yellow clear ball	TSL-12Y-LX-IL6-A1-P2-CLR	T16B006

General Requirements

Intertek Sample Number	ETL Cert. Number	Label Identification	Lens Orientation	Color Coded Wires
CRT1610241001-004-001	7080585	Pass	Pass	Yellow/White
CRT1610241001-004-002	7080586	Pass	Pass	Yellow/White
CRT1610241001-004-003	7080587	Pass	Pass	Yellow/White
CRT1610241001-004-004	7080588	Pass	Pass	Yellow/White
CRT1610241001-004-005	7080589	Pass	Pass	Yellow/White
CRT1610241001-008-003	7080590	Pass	Pass	Yellow/White
CRT1611071057-004-001	5595517	Pass	Pass	Yellow/White
CRT1611071057-004-002	6511623	Pass	Pass	Yellow/White
CRT1611071057-004-003	6511626	Pass	Pass	Yellow/White

General Requirements

Intertek Sample Number	600V / 20 AWG Min.	Wire Length \geq 39"	Service Rating +105°C
CRT1610241001-004-001	600V/18AWG	Pass	Pass
CRT1610241001-004-002	600V/18AWG	Pass	Pass
CRT1610241001-004-003	600V/18AWG	Pass	Pass
CRT1610241001-004-004	600V/18AWG	Pass	Pass
CRT1610241001-004-005	600V/18AWG	Pass	Pass
CRT1610241001-008-003	600V/18AWG	Pass	Pass
CRT1611071057-004-001	600V/18AWG	Pass	Pass
CRT1611071057-004-002	600V/18AWG	Pass	Pass
CRT1611071057-004-003	600V/18AWG	Pass	Pass

Picture(s)

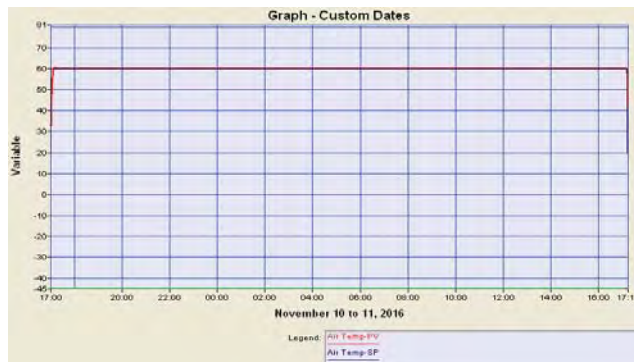
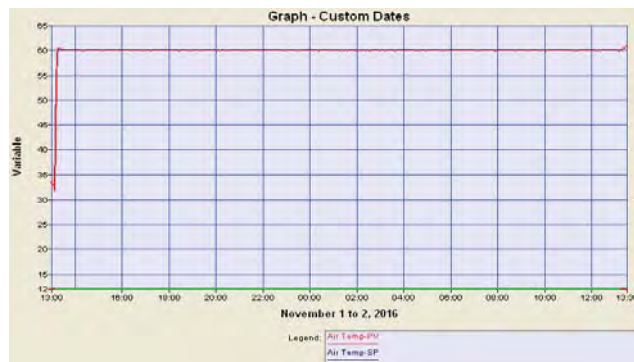


Conditioning 6.4.2

The submitted LED signal modules were subjected to conditioning prior to the environmental tests. The samples were energized for a minimum of 24 hours, at 100% duty cycle in an ambient temperature of +60°C (+140°F). At the conclusion of the test, the modules shall be visually inspected for damage and checked for proper operation.

Results

Intertek Sample Number	Description	Visual Inspection		Operational Check	
		Pre	Post	Pre	Post
CRT1610241001-004-001	12" yellow tinted ball	Pass	Pass	Pass	Pass
CRT1610241001-004-002	12" yellow tinted ball	Pass	Pass	Pass	Pass
CRT1610241001-004-003	12" yellow tinted ball	Pass	Pass	Pass	Pass
CRT1610241001-004-004	12" yellow tinted ball	Pass	Pass	Pass	Pass
CRT1610241001-004-005	12" yellow tinted ball	Pass	Pass	Pass	Pass
CRT1610241001-008-003	12" yellow tinted ball	Pass	Pass	Pass	Pass
CRT1611071057-004-001	12" yellow clear ball	Pass	Pass	Pass	Pass
CRT1611071057-004-002	12" yellow clear ball	Pass	Pass	Pass	Pass
CRT1611071057-004-003	12" yellow clear ball	Pass	Pass	Pass	Pass



Measured Voltage: 119.3 Vac

Complies: ☒ YES ☐ NO

Tested By:	John Robins	Signature or initials:		Comp. Date	11/2/16
Reviewed By:	cwm	Signature or initials:		Comp. Date	11/11/16
Test Equipment Used:	1,2				
Amb (°C):	na	RH%	na		

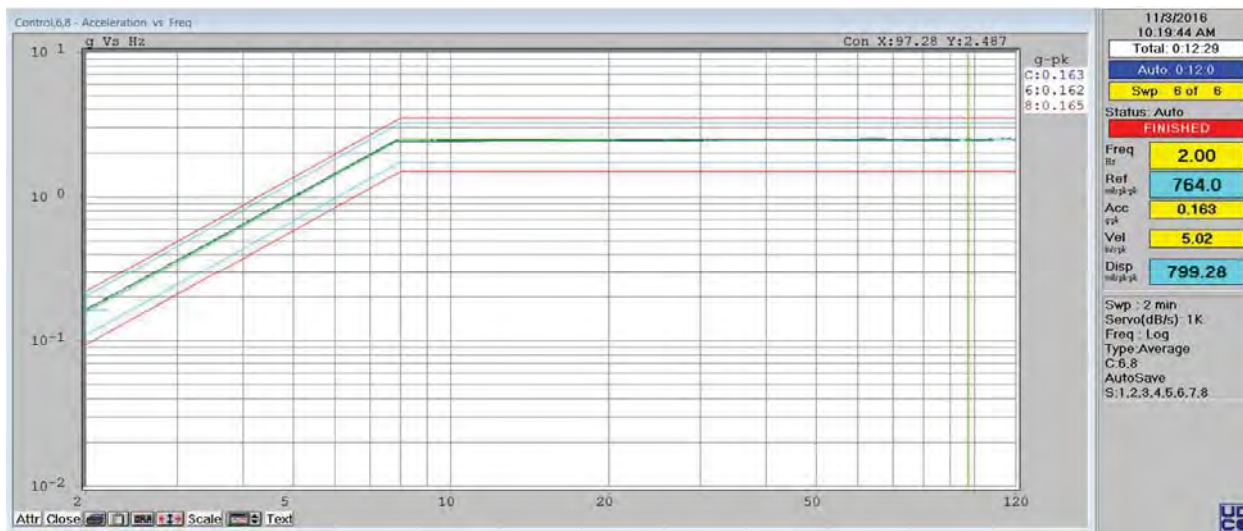
Mechanical Vibration 6.4.3.1

The submitted LED signal modules were securely mounted in traffic signal housings and vibrated along each axes for three 4 minute sweep cycles at a displacement of 0.764" from 2 to 8 Hz and 2.5 Gs from 8 to 120 Hz. The modules were energized before and after each axis sweep. The modules were visually inspected after testing. Testing was conducted in accordance with MIL-STD-883, method 2007. At the conclusion of the test, the module shall be free of damage and fully operational.

Results

Intertek Sample Number	Description	x-axis lateral	y-axis horizontal	z-axis vertical	Visual Inspection	Operational Check
CRT1610241001-004-001	12" yellow tinted ball	X	X	X	Pass	Pass
CRT1610241001-004-002	12" yellow tinted ball	X	X	X	Pass	Pass
CRT1610241001-004-003	12" yellow tinted ball	X	X	X	Pass	Pass
CRT1610241001-004-004	12" yellow tinted ball	X	X	X	Pass	Pass
CRT1610241001-004-005	12" yellow tinted ball	X	X	X	Pass	Pass
CRT1610241001-008-003	12" yellow tinted ball	X	X	X	Pass	Pass

Sample Vibration Plot



Complies: ☒ YES ☐ NO

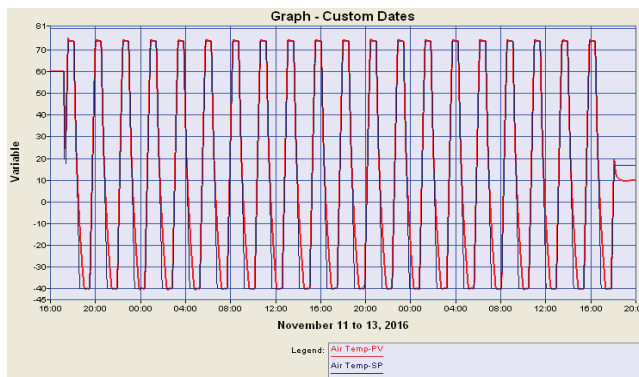
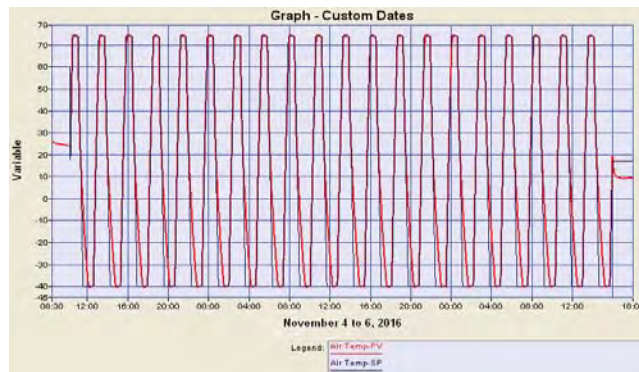
Tested By:	Gordon West	Signature or initials:	<i>Gordon West</i>	Comp. Date	11/3/16
Reviewed By:	cwm	Signature or initials:	<i>cwm</i>		
Test Equipment Used:	3,4,5,6,7				
Amb (°C):	23.5	RH%	39		

Temperature Cycling 6.4.3.2

The submitted tinted and clear LED signal modules were subjected to temperature cycling according to MIL-STD-883, Method 1010. Twenty cycles were performed with a 30 minute transfer time between temperature extremes and a 30 minute dwell time at the extremes. The temperature cycled between -40°C and +74°C. The samples were non-operating. At the conclusion of the test, the module shall be free of damage and moisture and be fully operational.

Results

Intertek Sample Number	Description	Visual Inspection	Operational Check
CRT1610241001-004-001	12" yellow tinted ball	Pass	Pass
CRT1610241001-004-002	12" yellow tinted ball	Pass	Pass
CRT1610241001-004-003	12" yellow tinted ball	Pass	Pass
CRT1610241001-004-004	12" yellow tinted ball	Pass	Pass
CRT1610241001-004-005	12" yellow tinted ball	Pass	Pass
CRT1610241001-008-003	12" yellow tinted ball	Pass	Pass
CRT1611071057-004-001	12" yellow clear ball	Pass	Pass
CRT1611071057-004-002	12" yellow clear ball	Pass	Pass
CRT1611071057-004-003	12" yellow clear ball	Pass	Pass



Complies: ☒ YES ☐ NO

Tested By:	John Robins	Signature or initials:	<i>JR</i>	Comp. Date	11/6/16
Reviewed By:	cwm	Signature or initials:	<i>cwm</i>	Comp. Date	11/13/16
Test Equipment Used:	1				
Amb (°C):	na	RH%	na		

Moisture Resistance 6.4.3.3

The submitted tinted and clear LED signal modules were subjected to the rain and blowing rain test per MIL-STD-810F, Test Method 506.4, Procedure I. The test was performed on standalone modules without a protective housing. The rainfall rate was 1.7 mm/min (4in/hr) and the droplet size shall predominantly be between 0.5mm and 4.5mm (0.02 to 0.18 in). The samples were oriented such that the lens is directed towards the wind source when at a zero rotation angle. The samples were rotated at a rate of 4 degrees per minute along the vertical axis, from an orientation of -60 to +60 degrees during the test. The duration of the test is 30 minutes, and the samples were energized throughout the test. The water temperature was $25^{\circ} \pm 5^{\circ}\text{C}$ ($77^{\circ} \pm 9^{\circ}\text{F}$) and the wind velocity was 80 km/hr (50 mph). At the conclusion of the test, the module shall be free of damage and moisture and be fully operational.

Results

Intertek Sample Number	Description	Visual Inspection	Operational Check
CRT1610241001-004-001	12" yellow tinted ball	Pass	Pass
CRT1610241001-004-002	12" yellow tinted ball	Pass	Pass
CRT1610241001-004-003	12" yellow tinted ball	Pass	Pass
CRT1610241001-004-004	12" yellow tinted ball	Pass	Pass
CRT1610241001-004-005	12" yellow tinted ball	Pass	Pass
CRT1610241001-008-003	12" yellow tinted ball	Pass	Pass
CRT1611071057-004-001	12" yellow clear ball	Pass	Pass
CRT1611071057-004-002	12" yellow clear ball	Pass	Pass
CRT1611071057-004-003	12" yellow clear ball	Pass	Pass

Requirement: Signal Still Operational and No Moisture In The Housing

Intertek Sample Number	Sample Temp. at start (°C)	Water Temperature 25C +/- 5C			
		Start	10 minutes in.	20 minutes in.	30 minutes in.
CRT1610241001-004-001	40	29.5	29.2	28.2	27.1
CRT1610241001-004-002	40				
CRT1610241001-004-003	40	24.4	24.8	24.4	24.6
CRT1610241001-004-004	40	26.0	25.5	25.4	25.6
CRT1610241001-004-005	40	28.1	28.0	26.3	23.8
CRT1610241001-008-003	40				
CRT1611071057-004-001	40	27.4	27.0	28.4	27.1
CRT1611071057-004-002	40				
CRT1611071057-004-003	40	26.0	25.5	25.4	25.6

* Water temperature is °C

Recorded rainfall rate:	4.3	in/hr
Recorded wind velocity:	48-52	mph

Complies: ☒ YES ☐ NO

Tested By:	Kurt Dobler	Signature or initials:	kfd	Comp. Date:	2/24/17
Reviewed By:	JND	Signature or initials:	JND		
Test Equipment Used:	21,22,23,24				
Amb (°C):	NA	RH%	NA		

Luminous Intensity 6.4.4.1 through 6.4.4.4

The intensity distribution tests on the submitted LED traffic signal modules were performed with the Intertek 25 meter Goniophotometer. The goniophotometer was in accordance with the goniometer described in Section 11.02 (Test Apparatus) of the Institute of Transportation Engineers' Vehicle Traffic Control Signal Heads Standard Test Method. The calibration of the goniophotometer is traceable to the National Institute of Standards and Technology. The LED modules were operated at 120 volts AC. The alignment of the LED module was performed in accordance with Section 11.03 (Alignment of Optical Unit for Test) of the Institute of Transportation Engineers' Vehicle Traffic Control Signal Heads Standard Test Method.

The submitted LED signal modules were tested for maintained minimum luminous intensity at each of 78 points indicated in Table 1, of the referenced specification. These measurements were recorded at an ambient temperature of 25°C. The yellow LED signal modules was operated on a 12 ½ % duty cycle for 1 hour (5 second "on" / 35 seconds "off" duty cycle). A measurement was taken at the end of the duty cycle and the module was then operated at a 100% duty cycle until stabilized. A factor was generated to rate the stable data back to the end of the 12½% duty cycle. A relative luminous intensity measurement is taken in a region from 0 to 7.5° down, and from 7.5° left to 7.5° right. The measurement is taken at 80 Vac, 120 Vac and 135 Vac. When the 80 Vac and 135 Vac factors are applied to the photometric data the units shall still meet the photometric requirements of each model.

A diminution factor was measured by using the submitted samples. The modules were mounted in a dual compartment temperature chamber with the lensed portion in one compartment and all portions behind the lens within the other compartment. At room ambient temperature (both inside and outside the chamber) and in calm air outside the chamber, the modules were energized per the conditions described above and a single on-axis reading (IA) taken and recorded. With the modules off, the chamber was heated to 74°C behind the lens and 49°C in front of the lens, and allowed to stabilize. Following stabilization, the modules were energized per the above cycle and the single on-axis reading (IH) taken and recorded. A diminution factor was calculated (IH/IA).The readings recorded initially were factored by the diminution factor.

Luminous Intensity 6.4.4.1 through 6.4.4.4

Sample:	CRT1610241001-004-004				Input voltage		Measured Input Voltage				0, 0 Lum. Intensity		Vac Variation Factor		MMU Factor	
Module	12" Ball				80Vac		80.3		Vac		1655 Candela		0.989		0.896	
Color:	Yellow				120Vac		120.2		Vac		1673 Candela		1.000		5/35 Factor	
Lens	Tinted				135Vac		135.6		Vac		1670 Candela		0.998		1.048	
Photometric Test Distance: 25 meters																
Max. cd	2730	25°C		25°C		25°C		74°C/49°C		74°C/49°C		74°C/49°C				
Vertical	Horizontal	Rated 80Vac		Measured 120Vac		Rated 135Vac		Rated 80Vac		Measured 120Vac		Rated 135Vac		Table 1		
Angle	Angle	Candela	Candela	Candela	Candela	Candela	Candela	Candela	Candela	Candela	Candela	Candela	Candela	Candela	Minimum	
Up/Down	Left/Right	Left	Right	Left	Right	Left	Right	Left	Right	Left	Right	Left	Right	Left	Candela	
12.5U	2.5	224	223	226	226	226	225	201	200	203	202	202	202	202	91	
12.5U	7.5	183	178	185	180	185	180	164	160	166	161	166	161	161	73	
7.5U	2.5	424	401	429	405	428	404	380	359	384	363	384	362	362	173	
7.5U	7.5	352	306	356	309	356	309	316	274	319	277	319	277	277	137	
7.5U	12.5	253	200	255	203	255	202	226	180	229	182	229	181	181	100	
2.5U	2.5	1164	1081	1177	1093	1175	1091	1044	969	1055	980	1053	978	978	373	
2.5U	7.5	953	774	963	782	962	781	854	694	863	701	862	700	700	309	
2.5U	12.5	637	464	643	469	642	468	571	416	577	420	576	420	420	209	
2.5U	17.5	420	259	425	261	424	261	376	232	381	234	380	234	234	118	
2.5U	22.5	252	147	255	148	254	148	226	132	228	133	228	133	133	64	
2.5D	2.5	2056	2055	2079	2077	2075	2074	1843	1842	1863	1862	1860	1859	1859	892	
2.5D	7.5	1718	1651	1737	1669	1734	1666	1540	1480	1557	1496	1554	1493	1493	728	
2.5D	12.5	1155	1076	1168	1088	1166	1086	1035	965	1047	975	1045	973	973	501	
2.5D	17.5	730	594	738	601	737	600	654	533	661	538	660	537	537	291	
2.5D	22.5	415	331	419	335	419	334	372	297	376	300	375	299	299	155	
2.5D	27.5	229	192	232	195	231	194	206	172	208	174	207	174	174	82	
7.5D	2.5	1472	1498	1488	1515	1486	1512	1320	1343	1334	1358	1332	1355	1355	701	
7.5D	7.5	1145	1277	1157	1291	1155	1289	1026	1145	1037	1157	1035	1155	1155	582	
7.5D	12.5	737	903	745	913	743	911	660	809	667	818	666	817	817	391	
7.5D	17.5	459	548	464	554	463	553	411	491	416	497	415	496	496	228	
7.5D	22.5	243	318	246	321	245	321	218	285	220	288	220	287	287	118	
7.5D	27.5	133	193	135	195	135	194	120	173	121	174	121	174	174	64	
12.5D	2.5	646	655	653	662	651	661	579	587	585	593	584	592	592	273	
12.5D	7.5	533	520	539	526	538	525	478	466	483	471	482	470	470	218	
12.5D	12.5	348	340	352	344	351	343	312	305	315	308	315	308	308	155	
12.5D	17.5	217	205	219	207	219	207	194	184	196	186	196	185	185	91	
12.5D	22.5	128	122	129	123	129	123	114	109	116	110	115	110	110	46	
12.5D	27.5	77	80	78	80	78	80	69	71	70	72	70	72	72	27	
17.5D	2.5	402	389	407	393	406	392	361	349	365	352	364	352	352	127	
17.5D	7.5	336	297	339	300	339	300	301	266	304	269	304	269	269	100	
17.5D	12.5	231	196	234	198	234	197	207	175	210	177	209	177	177	73	
17.5D	17.5	148	123	150	124	150	124	133	110	134	112	134	111	111	36	
17.5D	22.5	94	81	95	82	94	81	84	72	85	73	85	73	73	18	
22.5D	2.5	256	249	258	252	258	252	229	223	232	226	231	225	225	91	
22.5D	7.5	220	201	223	203	222	203	197	180	199	182	199	182	182	73	
22.5D	12.5	156	140	158	141	157	141	140	125	141	127	141	126	126	55	
22.5D	17.5	106	91	107	92	107	92	95	82	96	82	96	82	82	27	
27.5D	2.5	156	153	158	154	157	154	140	137	141	138	141	138	138	64	
27.5D	7.5	136	127	137	128	137	128	121	114	123	115	123	115	115	46	

Luminous Intensity 6.4.4.1 through 6.4.4.4

Sample:	CRT1610241001-004-005				Input voltage		Measured Input Voltage		0, 0 Lum. Intensity		Vac Variation Factor		MMU Factor	
Module	12" Ball				80Vac		80.3 Vac		1669 Candela		0.996		0.891	
Color:	Yellow				120Vac		120.5 Vac		1675 Candela		1.000		5/35 Factor	
Lens	Tinted				135Vac		135.2 Vac		1675 Candela		1.000		1.035	
Photometric Test Distance: 25 meters														
Max. cd	2730	25°C		25°C		25°C		74°C/49°C		74°C/49°C		74°C/49°C		
Vertical	Horizontal	Rated 80Vac		Measured 120Vac		Rated 135Vac		Rated 80Vac		Measured 120Vac		Rated 135Vac		Table 1
Angle	Angle	Candela	Candela	Candela	Candela	Candela	Candela	Candela	Candela	Candela	Candela	Candela	Candela	Minimum
Up/Down	Left/Right	Left	Right	Left	Right	Left	Right	Left	Right	Left	Right	Left	Right	Candela
12.5U	2.5	219	222	220	223	220	223	195	198	196	198	196	198	91
12.5U	7.5	175	183	176	184	176	184	156	163	157	164	157	164	73
7.5U	2.5	401	415	402	416	402	416	357	370	358	371	358	371	173
7.5U	7.5	311	342	312	343	312	343	277	305	278	306	278	306	137
7.5U	12.5	209	238	209	239	209	239	186	212	187	213	187	213	100
2.5U	2.5	1107	1123	1111	1127	1111	1127	987	1001	990	1004	990	1004	373
2.5U	7.5	828	893	831	896	831	896	738	795	741	798	741	798	309
2.5U	12.5	508	589	510	591	510	591	453	524	455	526	455	526	209
2.5U	17.5	295	362	296	363	296	363	263	323	263	324	263	324	118
2.5U	22.5	174	212	175	213	175	213	155	189	156	190	156	190	64
2.5D	2.5	2019	1983	2026	1990	2026	1990	1799	1767	1806	1773	1806	1773	892
2.5D	7.5	1670	1632	1676	1638	1676	1638	1489	1455	1494	1460	1494	1460	728
2.5D	12.5	1138	1128	1142	1132	1142	1132	1014	1005	1018	1009	1018	1009	501
2.5D	17.5	657	687	659	689	659	689	586	612	588	614	588	614	291
2.5D	22.5	375	384	377	386	377	386	334	343	336	344	336	344	155
2.5D	27.5	221	215	222	216	222	216	197	191	198	192	198	192	82
7.5D	2.5	1406	1401	1411	1406	1411	1406	1253	1249	1258	1253	1258	1253	701
7.5D	7.5	1172	1145	1176	1150	1176	1150	1045	1021	1049	1025	1049	1025	582
7.5D	12.5	809	770	812	773	812	773	721	687	724	689	724	689	391
7.5D	17.5	490	475	492	477	492	477	437	424	438	425	438	425	228
7.5D	22.5	272	271	273	272	273	272	242	241	243	242	243	242	118
7.5D	27.5	159	154	159	154	159	154	142	137	142	137	142	137	64
12.5D	2.5	654	664	657	666	657	666	583	592	585	594	585	594	273
12.5D	7.5	514	537	516	538	516	538	459	478	460	480	460	480	218
12.5D	12.5	331	353	332	354	332	354	295	315	296	316	296	316	155
12.5D	17.5	196	221	196	222	196	222	174	197	175	198	175	198	91
12.5D	22.5	113	133	113	133	113	133	101	118	101	119	101	119	46
12.5D	27.5	72	80	73	81	73	81	64	72	65	72	65	72	27
17.5D	2.5	393	397	394	398	394	398	350	354	351	355	351	355	127
17.5D	7.5	310	327	311	328	311	328	276	291	277	292	277	292	100
17.5D	12.5	205	224	206	225	206	225	183	200	183	201	183	201	73
17.5D	17.5	127	145	128	145	128	145	114	129	114	130	114	130	36
17.5D	22.5	81	93	81	93	81	93	72	83	72	83	72	83	18
22.5D	2.5	252	253	253	254	253	254	225	225	226	226	226	226	91
22.5D	7.5	207	213	208	214	208	214	185	190	186	191	186	191	73
22.5D	12.5	144	150	145	150	145	150	129	134	129	134	129	134	55
22.5D	17.5	95	103	96	103	96	103	85	92	85	92	85	92	27
27.5D	2.5	156	154	157	154	157	154	139	137	140	137	140	137	64
27.5D	7.5	132	130	132	131	132	131	117	116	118	117	118	117	46

Luminous Intensity 6.4.4.1 through 6.4.4.4

Sample:	CRT1610241001-008-003				Input voltage		Measured Input Voltage		0, 0 Lum. Intensity		Vac Variation Factor		MMU Factor	
Module	12" Ball				80Vac		80.2 Vac		1573 Candela		0.997		0.895	
Color:	Yellow				120Vac		120.1 Vac		1578 Candela		1.000		5/35 Factor	
Lens	Tinted				135Vac		135.2 Vac		1574 Candela		0.997		1.032	
Photometric Test Distance: 25 meters														
Max. cd	2730	25°C		25°C		25°C		74°C/49°C		74°C/49°C		74°C/49°C		
Vertical	Horizontal	Rated 80Vac		Measured 120Vac		Rated 135Vac		Rated 80Vac		Measured 120Vac		Rated 135Vac		Table 1
Angle	Angle	Candela	Candela	Candela	Candela	Candela	Candela	Candela	Candela	Candela	Candela	Candela	Candela	Minimum
Up/Down	Left/Right	Left	Right	Left	Right	Left	Right	Left	Right	Left	Right	Left	Right	Candela
12.5U	2.5	208	213	209	213	208	213	186	190	187	191	186	190	91
12.5U	7.5	165	177	166	178	165	177	148	159	148	159	148	159	73
7.5U	2.5	378	392	379	394	378	393	338	351	339	352	338	351	173
7.5U	7.5	296	323	297	324	296	324	265	289	265	290	265	290	137
7.5U	12.5	201	229	202	229	201	229	180	205	180	205	180	205	100
2.5U	2.5	1024	1052	1027	1055	1025	1052	916	941	919	944	917	942	373
2.5U	7.5	746	841	748	844	746	842	667	753	669	755	668	754	309
2.5U	12.5	470	551	471	553	470	551	420	493	422	495	421	493	209
2.5U	17.5	280	342	281	343	280	342	251	306	252	307	251	306	118
2.5U	22.5	168	211	168	212	168	211	150	189	151	189	150	189	64
2.5D	2.5	1979	1917	1985	1923	1980	1918	1771	1716	1777	1721	1772	1717	892
2.5D	7.5	1579	1541	1584	1545	1580	1542	1413	1379	1417	1383	1414	1379	728
2.5D	12.5	1054	1070	1057	1074	1054	1071	943	958	946	961	944	958	501
2.5D	17.5	608	629	610	631	609	630	544	563	546	565	545	564	291
2.5D	22.5	360	375	361	377	360	376	322	336	323	337	323	336	155
2.5D	27.5	214	209	215	210	214	210	191	187	192	188	192	188	82
7.5D	2.5	1276	1258	1280	1262	1277	1258	1142	1125	1146	1129	1143	1126	701
7.5D	7.5	1028	995	1031	999	1029	996	920	891	923	894	920	891	582
7.5D	12.5	684	666	686	668	684	667	612	596	614	598	612	596	391
7.5D	17.5	407	417	408	418	407	417	364	373	365	374	364	373	228
7.5D	22.5	234	239	235	240	234	239	209	214	210	214	209	214	118
7.5D	27.5	142	140	142	140	142	140	127	125	127	125	127	125	64
12.5D	2.5	559	553	561	555	560	554	501	495	502	497	501	496	273
12.5D	7.5	433	460	435	461	434	460	388	412	389	413	388	412	218
12.5D	12.5	285	312	285	313	285	312	255	279	255	280	255	279	155
12.5D	17.5	174	197	175	198	174	197	156	176	156	177	156	176	91
12.5D	22.5	107	122	107	123	107	122	95	109	96	110	95	109	46
12.5D	27.5	70	78	71	78	70	78	63	69	63	70	63	70	27
17.5D	2.5	349	359	350	361	349	360	312	322	313	323	312	322	127
17.5D	7.5	277	295	278	296	277	295	248	264	249	265	248	264	100
17.5D	12.5	186	205	186	206	186	205	166	184	167	184	166	184	73
17.5D	17.5	119	135	119	135	119	135	107	121	107	121	107	121	36
17.5D	22.5	79	90	79	90	79	90	70	80	71	80	70	80	18
22.5D	2.5	229	230	230	231	230	230	205	206	206	206	205	206	91
22.5D	7.5	188	196	189	196	188	196	168	175	169	176	168	175	73
22.5D	12.5	133	139	133	140	133	140	119	125	119	125	119	125	55
22.5D	17.5	90	99	91	99	90	99	81	88	81	89	81	88	27
27.5D	2.5	145	143	146	144	145	144	130	128	130	129	130	128	64
27.5D	7.5	123	124	124	124	124	124	111	111	111	111	111	111	46

Luminous Intensity 6.4.4.1 through 6.4.4.4

Sample:	CRT1611071057-004-001				Input voltage		Measured Input Voltage			0, 0 Lum. Intensity			Vac Variation Factor		MMLI Factor
Module	12" Ball				80Vac		80.3 Vac			1715 Candela			0.994		0.890
Color:	Yellow				120Vac		120.1 Vac			1726 Candela			1.000		5/35 Factor
Lens	Clear				135Vac		135.5 Vac			1734 Candela			1.005		1.041
Photometric Test Distance: 25 meters															
Max. cd	2730	25°C		25°C		25°C		74°C/49°C		74°C/49°C		74°C/49°C			
Vertical	Horizontal	Rated 80Vac		Measured 120Vac		Rated 135Vac		Rated 80Vac		Measured 120Vac		Rated 135Vac		Table 1	
Angle	Angle	Candela	Candela	Candela	Candela	Candela	Candela	Candela	Candela	Candela	Candela	Candela	Candela	Candela	Minimum
Up/Down	Left/Right	Left	Right	Left	Right	Left	Right	Left	Right	Left	Right	Left	Right	Left	Candela
12.5U	2.5	228	230	229	231	230	232	203	205	204	206	205	207		91
12.5U	7.5	182	189	183	191	184	192	162	169	163	170	164	171		73
7.5U	2.5	402	419	404	422	406	424	358	373	360	375	362	377		173
7.5U	7.5	308	353	310	355	312	357	275	314	276	316	278	318		137
7.5U	12.5	204	257	206	259	207	260	182	229	183	230	184	231		100
2.5U	2.5	1065	1137	1072	1145	1077	1150	948	1013	954	1019	959	1024		373
2.5U	7.5	757	952	762	958	765	963	674	848	678	853	681	857		309
2.5U	12.5	465	658	468	663	470	666	414	586	417	590	419	593		209
2.5U	17.5	262	414	264	416	265	418	234	368	235	371	236	372		118
2.5U	22.5	153	269	154	271	155	272	136	240	137	241	138	243		64
2.5D	2.5	2237	2233	2252	2247	2262	2258	1992	1989	2005	2001	2014	2011		892
2.5D	7.5	1743	1763	1754	1775	1762	1783	1552	1570	1562	1580	1569	1588		728
2.5D	12.5	1121	1221	1128	1229	1133	1235	998	1087	1004	1094	1009	1099		501
2.5D	17.5	614	728	618	733	621	736	547	648	550	652	553	655		291
2.5D	22.5	349	425	351	428	353	430	311	379	313	381	314	383		155
2.5D	27.5	207	234	208	235	209	237	184	208	186	210	187	211		82
7.5D	2.5	1483	1378	1492	1387	1499	1394	1320	1227	1329	1235	1335	1241		701
7.5D	7.5	1241	1083	1249	1090	1254	1095	1105	965	1112	971	1117	975		582
7.5D	12.5	876	669	881	673	885	676	780	595	785	599	788	602		391
7.5D	17.5	536	413	540	416	542	418	478	368	481	370	483	372		228
7.5D	22.5	317	227	319	229	321	230	283	202	284	204	286	205		118
7.5D	27.5	197	130	198	131	199	131	176	116	177	116	177	117		64
12.5D	2.5	605	598	609	602	612	605	539	532	543	536	545	538		273
12.5D	7.5	469	497	472	501	475	503	418	443	421	446	423	448		218
12.5D	12.5	319	327	321	329	322	331	284	291	285	293	287	295		155
12.5D	17.5	197	210	198	211	199	212	176	187	177	188	177	189		91
12.5D	22.5	124	127	125	128	125	129	110	113	111	114	112	115		46
12.5D	27.5	84	81	85	81	85	82	75	72	76	72	76	73		27
17.5D	2.5	374	390	376	392	378	394	333	347	335	349	336	351		127
17.5D	7.5	290	327	292	329	294	331	259	291	260	293	261	294		100
17.5D	12.5	199	224	200	225	201	226	177	199	178	201	179	202		73
17.5D	17.5	128	150	129	151	129	152	114	134	114	135	115	135		36
17.5D	22.5	87	97	87	97	87	98	77	86	78	87	78	87		18
22.5D	2.5	249	253	250	255	252	256	222	226	223	227	224	228		91
22.5D	7.5	201	217	202	219	203	220	179	194	180	195	181	196		73
22.5D	12.5	143	156	144	157	145	158	127	139	128	140	129	140		55
22.5D	17.5	95	109	96	109	96	110	85	97	85	97	86	98		27
27.5D	2.5	159	162	160	163	161	164	142	145	143	146	143	146		64
27.5D	7.5	133	140	134	141	134	141	118	125	119	125	119	126		46

Luminous Intensity 6.4.4.1 through 6.4.4.4

Sample: CRT1611071057-004-002				Input voltage		Measured Input Voltage		0, 0 Lum. Intensity		Vac Variation Factor		MMU Factor		
Module 12" Ball				80Vac		80.1 Vac		1670 Candela		0.991		0.895		
Color: Yellow				120Vac		120.2 Vac		1686 Candela		1.000		5/35 Factor		
Lens Clear				135Vac		135.2 Vac		1686 Candela		1.000		1.080		
Photometric Test Distance: 25 meters														
Max. cd	2730	25°C		25°C		25°C		74°C/49°C		74°C/49°C		74°C/49°C		
Vertical	Horizontal	Rated 80Vac		Measured 120Vac		Rated 135Vac		Rated 80Vac		Measured 120Vac		Rated 135Vac		
Angle	Angle	Candela	Candela	Candela	Candela	Candela	Candela	Candela	Candela	Candela	Candela	Candela	Table 1	
Up/Down	Left/Right	Left	Right	Left	Right	Left	Right	Left	Right	Left	Right	Left	Right	Candela
12.5U	2.5	228	232	230	235	230	235	204	208	206	210	206	210	91
12.5U	7.5	180	195	182	197	182	197	161	174	163	176	163	176	73
7.5U	2.5	416	420	420	424	420	424	372	376	375	379	375	379	173
7.5U	7.5	329	338	332	342	332	342	294	303	297	306	297	306	137
7.5U	12.5	228	235	230	237	230	237	204	210	206	212	206	212	100
2.5U	2.5	1141	1153	1152	1164	1152	1164	1021	1031	1030	1041	1030	1041	373
2.5U	7.5	868	851	876	859	876	859	776	761	784	769	784	769	309
2.5U	12.5	570	561	576	567	576	567	510	502	515	507	515	507	209
2.5U	17.5	344	334	347	337	347	337	307	299	310	302	310	302	118
2.5U	22.5	214	200	216	202	216	202	191	179	193	181	193	181	64
2.5D	2.5	2289	2223	2311	2244	2311	2244	2048	1988	2067	2007	2067	2007	892
2.5D	7.5	1864	1766	1882	1783	1882	1783	1668	1580	1684	1595	1684	1595	728
2.5D	12.5	1273	1173	1285	1184	1285	1184	1138	1049	1149	1059	1149	1059	501
2.5D	17.5	736	690	743	697	743	697	658	618	665	624	665	624	291
2.5D	22.5	423	401	427	405	427	405	378	358	382	362	382	362	155
2.5D	27.5	249	222	252	225	252	225	223	199	225	201	225	201	82
7.5D	2.5	1404	1429	1418	1442	1418	1442	1256	1278	1268	1290	1268	1290	701
7.5D	7.5	1112	1199	1123	1210	1123	1210	995	1072	1004	1083	1004	1083	582
7.5D	12.5	713	803	720	811	720	811	638	718	644	725	644	725	391
7.5D	17.5	400	526	404	531	404	531	358	471	361	475	361	475	228
7.5D	22.5	212	309	214	312	214	312	190	276	192	279	192	279	118
7.5D	27.5	128	183	129	184	129	184	114	163	116	165	116	165	64
12.5D	2.5	613	625	618	631	618	631	548	559	553	565	553	565	273
12.5D	7.5	485	508	489	512	489	512	434	454	438	458	438	458	218
12.5D	12.5	313	358	316	362	316	362	280	321	283	324	283	324	155
12.5D	17.5	189	230	190	232	190	232	169	206	170	208	170	208	91
12.5D	22.5	114	143	115	144	115	144	102	128	103	129	103	129	46
12.5D	27.5	76	90	77	91	77	91	68	81	69	82	69	82	27
17.5D	2.5	393	399	397	403	397	403	352	357	355	361	355	361	127
17.5D	7.5	318	322	321	325	321	325	284	288	287	291	287	291	100
17.5D	12.5	213	226	215	228	215	228	190	202	192	204	192	204	73
17.5D	17.5	136	147	137	149	137	149	122	132	123	133	123	133	36
17.5D	22.5	89	99	89	100	89	100	79	88	80	89	80	89	18
22.5D	2.5	260	258	262	260	262	260	232	231	234	233	234	233	91
22.5D	7.5	219	212	221	214	221	214	196	189	197	191	197	191	73
22.5D	12.5	155	152	156	153	156	153	139	136	140	137	140	137	55
22.5D	17.5	105	106	106	107	106	107	94	95	95	96	95	96	27
27.5D	2.5	167	161	168	163	168	163	149	144	150	145	150	145	64
27.5D	7.5	144	133	145	135	145	135	128	119	130	120	130	120	46

Luminous Intensity 6.4.4.1 through 6.4.4.4

Sample:	CRT1611071057-004-003	Input voltage	Measured Input Voltage	0, 0 Lum. Intensity	Vac Variation Factor	MMLI Factor
Module	12" Ball	80Vac	80.2 Vac	1471 Candela	0.842	0.899
Color:	Yellow	120Vac	120.3 Vac	1747 Candela	1.000	5/35 Factor
Lens	Clear	135Vac	135.3 Vac	1742 Candela	0.997	1.047

Photometric Test Distance: 25 meters

Max. cd	2730	25°C		25°C		25°C		74°C/49°C		74°C/49°C		74°C/49°C		Table 1
Vertical	Horizontal	Rated 80Vac		Measured 120Vac		Rated 135Vac		Rated 80Vac		Measured 120Vac		Rated 135Vac		
Angle	Angle	Candela	Candela	Candela	Candela	Candela	Candela	Candela	Candela	Candela	Candela	Candela	Candela	Minimum
Up/Down	Left/Right	Left	Right	Left	Right	Left	Right	Left	Right	Left	Right	Left	Right	Candela
12.5U	2.5	198	200	235	237	234	236	178	180	211	213	211	213	91
12.5U	7.5	159	164	189	194	189	194	143	147	170	175	170	174	73
7.5U	2.5	349	374	415	444	414	443	314	336	373	399	372	398	173
7.5U	7.5	265	320	315	380	314	379	239	288	283	342	283	341	137
7.5U	12.5	173	241	205	286	205	286	155	217	184	257	184	257	100
2.5U	2.5	951	1047	1129	1243	1126	1240	855	941	1015	1118	1012	1115	373
2.5U	7.5	649	892	771	1059	769	1056	584	802	693	952	691	949	309
2.5U	12.5	374	636	445	755	443	753	337	572	400	679	398	677	209
2.5U	17.5	206	411	244	488	243	487	185	370	220	439	219	438	118
2.5U	22.5	117	260	139	309	138	308	105	234	125	278	124	277	64
2.5D	2.5	1879	1818	2232	2159	2226	2153	1690	1634	2007	1941	2001	1935	892
2.5D	7.5	1445	1453	1716	1726	1711	1721	1299	1307	1542	1552	1538	1547	728
2.5D	12.5	889	987	1056	1172	1053	1169	799	887	949	1054	946	1051	501
2.5D	17.5	471	600	560	713	558	711	424	539	503	641	502	639	291
2.5D	22.5	269	328	319	390	318	389	241	295	287	350	286	349	155
2.5D	27.5	155	183	185	218	184	217	140	165	166	196	166	195	82
7.5D	2.5	1212	1127	1439	1339	1435	1335	1089	1013	1294	1203	1290	1200	701
7.5D	7.5	1053	854	1251	1014	1247	1011	947	768	1124	912	1121	909	582
7.5D	12.5	769	520	914	618	911	616	692	468	822	555	819	554	391
7.5D	17.5	477	305	567	363	565	362	429	275	509	326	508	325	228
7.5D	22.5	286	170	340	202	339	201	257	153	306	181	305	181	118
7.5D	27.5	176	97	210	115	209	115	159	87	188	104	188	103	64
12.5D	2.5	509	507	605	603	603	601	458	456	544	542	542	540	273
12.5D	7.5	403	421	478	500	477	498	362	378	430	449	429	448	218
12.5D	12.5	281	279	334	331	333	330	253	251	300	298	299	297	155
12.5D	17.5	177	176	210	209	209	208	159	158	189	187	188	187	91
12.5D	22.5	113	107	134	127	133	127	101	96	120	115	120	114	46
12.5D	27.5	77	68	91	81	91	81	69	61	82	73	82	73	27
17.5D	2.5	321	332	382	395	380	393	289	299	343	355	342	354	127
17.5D	7.5	245	287	291	341	291	340	221	258	262	307	261	306	100
17.5D	12.5	167	197	198	234	197	233	150	177	178	210	177	210	73
17.5D	17.5	107	129	127	153	126	153	96	116	114	138	114	138	36
17.5D	22.5	73	84	87	99	86	99	66	75	78	89	78	89	18
22.5D	2.5	210	215	249	256	248	255	188	194	224	230	223	229	91
22.5D	7.5	165	189	196	225	195	224	148	170	176	202	176	202	73
22.5D	12.5	117	136	139	162	139	161	106	122	125	145	125	145	55
22.5D	17.5	79	95	94	113	93	112	71	85	84	101	84	101	27
27.5D	2.5	132	138	157	163	156	163	119	124	141	147	141	147	64
27.5D	7.5	107	121	127	144	127	143	96	109	114	129	114	129	46

Complies: ☒ YES ☐ NO

Tested By:	Matthew Benninger	Signature or initials:	mb	Comp. Date:	11/23/16
Reviewed By:	cwm	Signature or initials:	<i>cwm</i>		
Test Equipment Used:	8,9,10,11				
Amb (°C):	23	RH%:	31		

Lens Abrasion Resistance 6.4.5.2

A lens was mounted in the abrasion test fixture with the lens facing upwards. An abrading pad was cycled back and forth (1 cycle) for twelve cycles at $10\text{cm} \pm 2\text{cm}$ per second over the test surface of the lens. The abrading pad shall not be less than $2.5\text{cm} \pm 0.1\text{cm}$ square, constructed of 0000 steel wool rubber cemented to a rigid base shaped to the contour of the lens. The "grain" of the pad was perpendicular to the direction of motion. The abrading pad support was equal in size to the pad and the center of the support surface was within $\pm 2\text{mm}$ of parallel to the lens surface. The density of the abrading pad was such that when the pad was mounted to its support and is resting unweight on the lens, the base of the pad was no closer than 3.2mm to the lens at its closest point. When mounted on its support and resting on the lens, the abrading pad was weighted such that a pad pressure of $14\text{kPa} \pm 1\text{kPa}$ exists at the center and perpendicular to the face of the lens. A pivot was used to follow the contour of the lens.

Results

A single intensity point was measured before and after the abrasion. In all samples tested the abraded lens intensity measurement was at least 90% of the un-abraded lens intensity measurement.

12" Yellow Ball Tinted			
Sample	Pre Abrasion	Post Abrasion	Percentage
CRT1610241001-004-004	1673	1617	96.7
CRT1610241001-004-005	1675	1611	96.2
CRT1610241001-008-003	1578	1495	94.7

measurements in cd

12" Yellow Ball Clear			
Sample	Pre Abrasion	Post Abrasion	Percentage
CRT1611071057-004-001	1726	1682	97.5
CRT1611071057-004-002	1686	1679	99.6
CRT1611071057-004-003	1747	1681	96.2

measurements in cd

Measured Voltage:	120.3	Vac		
Measured Weight:	11	lbs		
Abrasion Pad	5.5	Sq. In		
Pad Pressure	2.0	psi	13.8	Kpa

Complies: ☒ YES ☐ NO

Tested By:	Matthew Benninger/VS	Signature or initials:	mb/vs	Comp. Date	12/20/2016 & 12/23/16
Reviewed By:	cwm	Signature or initials:	<i>[Signature]</i>		
Test Equipment Used:	8,9,10,11,20				
Amb (°C):	23	RH%	28		

Luminance Uniformity

Luminance measurements were taken at nine locations across the signal face. A spot size of one inch was used. The luminance meter was translated from side to side and up and down remaining normal to the sample surface. The measurements were used to determine luminance uniformity. The measurements were taken after operating on the same duty cycle used during the photometric test.

Results

The ratio between the maximum and the minimum luminance was less than 10 to 1. Data follows.

12" Yellow Ball Tinted			
Sample	CRT1610241001-004-004	CRT1610241001-004-005	CRT1610241001-008-003
Location	Luminance	Luminance	Luminance
1	909	1017	1067
2	2457	2887	2454
3	3124	2958	2899
4	2654	2181	2562
5	934	1035	1023
6	1482	1396	1692
7	4875	5120	3268
8	1999	1604	2065
9	691	824	913
Average	2125	2114	1994
Intensity Ratio	7.1 to 1.0	6.2 to 1.0	3.6 to 1.0

Note: Neutral density filter 1.0 was used for luminance measurements and are relative.

12" Yellow Ball Clear			
Sample	CRT1611071057-004-001	CRT1611071057-004-002	CRT1611071057-004-003
Location	Luminance	Luminance	Luminance
1	1512	1518	1758
2	2915	2469	2866
3	2755	2425	3033
4	2180	1935	2665
5	1128	1114	1475
6	1844	1813	1988
7	3311	3240	3674
8	2026	2117	2123
9	1074	1263	1056
Average	2083	1988	2293
Intensity Ratio	3.1 to 1.0	2.9 to 1.0	3.5 to 1.0

Note: Neutral density filter 1.0 was used for luminance measurements and are relative.

Luminance measurements are in cd/m²

Same 60 minute warm-up used for luminous intensity

Test distance is 19 feet with ¼ degree aperture using the PR 740

Measured Voltage: 119.9 - 120.1 Vac

Complies: ☒ YES ☐ NO

Tested By:	Kurt Dobler	Signature or initials:	kfd	Comp. Date	11/11/16
Reviewed By:	cwm	Signature or initials:	<i>cwm</i>		
Test Equipment Used:	2,3,12,13				
Amb (°C):	22.1	RH%	27		

Chromaticity 6.4.4.6

The chromaticity measurements were performed on the submitted LED Traffic Signal Modules with the spectroradiometer. The samples were operated at nominal input voltage and ambient temperature during the measurements. The measurements were taken from 380-780nm in 2nm increments.

The chromaticity measurements were taken at nine locations across the signal face. A spot size of one inch was used with the samples operating on the same duty cycle used during the photometric test. The spectro-radiometer was translated from side to side and up and down remaining normal to the sample surface. The average of the measurements are recorded.

Results

12" Yellow Ball		Chromaticity Coordinates	
Color	Sample	x	y
Yellow (Tinted)	CRT1610241001-004-004	0.571	0.426
	CRT1610241001-004-005	0.572	0.426
	CRT1610241001-008-003	0.578	0.420

12" Yellow Ball		Chromaticity Coordinates	
Color	Sample	x	y
Yellow (Tinted)	CRT1611071057-004-001	0.559	0.436
	CRT1611071057-004-002	0.558	0.437
	CRT1611071057-004-003	0.557	0.438

The chromaticity measurements pass the requirements of the referenced specification.

Measured Voltage:	119.9 - 120.1	Vac
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Complies: ☒ YES ☐ NO

Tested By:	Kurt Dobler/John Robins	Signature or initials:	kfd <i>JA</i>	Comp. Date	11/11/16
Reviewed By:	cwm	Signature or initials:	<i>AWM</i>		
Test Equipment Used:	2,3,12,13				
Amb (°C):	22.1	RH%	27		

Color Uniformity 6.4.4.7

Three samples of each model were tested. Nine color measurements were taken at different locations on the traffic signal face. The measurements were taken after operating on the same duty cycle used during the photometric test. The dominant wave length was found using the measured (x, y) coordinates and table 3.29 of "Color Science" by Wyszecki & Stiles.

Results

12" Yellow Ball Tinted									
Sample	CRT1610241001-004-004			CRT1610241001-004-005			CRT1610241001-008-003		
Location	x	y	Dominant	x	y	Dominant	x	y	Dominant
1	0.570	0.428	589	0.571	0.426	590	0.578	0.421	591
2	0.572	0.426	590	0.573	0.425	590	0.578	0.420	591
3	0.571	0.426	590	0.572	0.425	590	0.578	0.419	591
4	0.572	0.425	590	0.571	0.427	589	0.579	0.419	591
5	0.571	0.427	589	0.572	0.426	590	0.579	0.419	591
6	0.575	0.423	590	0.576	0.422	590	0.581	0.417	591
7	0.575	0.422	590	0.576	0.422	590	0.583	0.415	591
8	0.570	0.428	589	0.568	0.429	589	0.576	0.422	590
9	0.565	0.433	588	0.564	0.433	588	0.571	0.427	589
Average	0.571	0.426	589	0.572	0.426	590	0.578	0.420	591

12" Yellow Ball Tinted									
Sample	CRT1611071057-004-001			CRT1611071057-004-002			CRT1611071057-004-003		
Location	x	y	Dominant	x	y	Dominant	x	y	Dominant
1	0.560	0.435	588	0.559	0.436	588	0.557	0.437	588
2	0.561	0.433	588	0.560	0.435	588	0.559	0.435	588
3	0.560	0.434	588	0.557	0.438	587	0.558	0.436	588
4	0.557	0.437	588	0.556	0.438	587	0.557	0.437	588
5	0.556	0.438	587	0.553	0.441	587	0.556	0.439	587
6	0.565	0.430	589	0.565	0.431	589	0.562	0.433	588
7	0.564	0.431	589	0.563	0.432	588	0.561	0.434	588
8	0.556	0.438	587	0.556	0.438	587	0.555	0.439	587
9	0.551	0.443	587	0.549	0.445	586	0.546	0.447	586
Average	0.559	0.436	588	0.558	0.437	587	0.557	0.438	588

Measured Voltage: 119.9 - 120.1 Vac

Complies: ☒ YES ☐ NO

Tested By:	Kurt Dobler/John Robins	Signature or initials:	kfd <i>98</i>	Comp. Date	11/11/16
Reviewed By:	cwm	Signature or initials:	<i>cwm</i>		
Test Equipment Used:	2,3,12,13				
Amb (°C):	22.1	RH%	27		

Current Consumption 6.4.6.1

Three samples were measured for current flow in amperes. The measured current values are supplied for comparison of Product Quality Assurance current measurements on production modules. Current measurements were taken at start up.

Results



Measurements are in (mA)

12" Yellow Ball			
Sample	-40°C	25°C	74°C
CRT1610241001-004-001	85.4	77.6	74.6
CRT1610241001-004-002	85.6	77.2	74.4
CRT1610241001-004-003	86.4	77.8	74.7

The current consumption was not in excess of 120% of the label current values for an ambient temperature of 25°C.

Measured Voltage: 120.1 Vac

Complies: ☒ YES ☐ NO

Tested By:	John Robins	Signature or initials:		Comp. Date	11/10/16
Reviewed By:	cwm	Signature or initials:			
Test Equipment Used:	1,15				
Amb (°C):	na	RH%	na		

Low Voltage Turn Off 6.4.6.2

Three samples were measured to ensure compliance with the low voltage turn-off requirement. Each sample was fully illuminated at the nominal operating voltage. The applied voltage was then reduced to the point where there was no visible illumination.

Results

There was no visible illumination when the applied voltage was less than 35Vac RMS.

12" Yellow Ball	
Sample	Low Voltage Turn Off (Vac RMS)
CRT1610241001-004-001	63.0
CRT1610241001-004-002	63.8
CRT1610241001-004-003	64.9

Complies: ☒ YES ☐ NO

Tested By:	Kurt Dobler	Signature or initials:	kfd	Comp. Date:	11/9/16
Reviewed By:	cwm	Signature or initials:	<i>cwm</i>		
Test Equipment Used:	2,16				
Amb (°C):	72	RH%	37		

Turn-On/Turn-Off Times 6.4.6.3

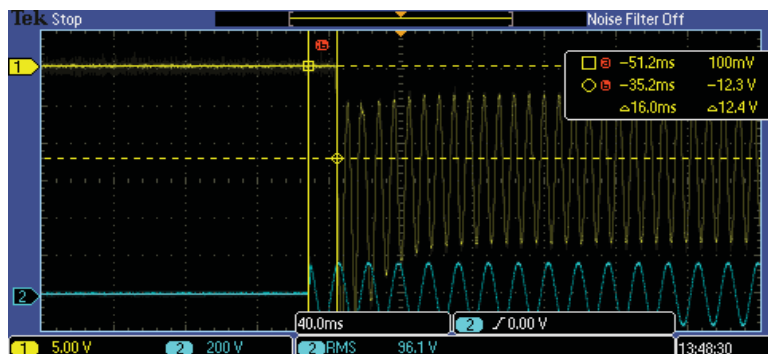
Three samples were measured to ensure compliance with the turn-on and turn-off requirements. The measurements were conducted using a two channel oscilloscope to measure the time delay between when the samples are energized at 120 Vac RMS and when the light output reaches 90% of full output. The same test equipment was used to measure the time delay between when the sample is de-energized and when the light output reaches 0% of full output.

Results

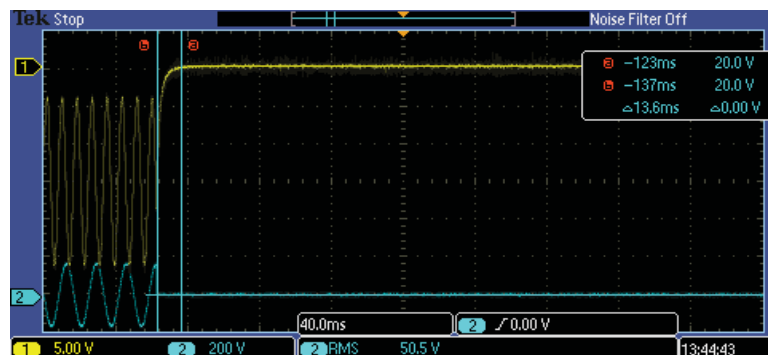
12" Yellow Ball		
Sample	Turn On	Turn Off
CRT1610241001-004-001	16.0	13.6
CRT1610241001-004-002	16.0	12.0
CRT1610241001-004-003	15.2	12.0

The "on" time and "off" time were within the 75ms requirement on all samples tested.

Sample Turn On Time



Sample Turn Off Time



Measured Voltage: 120 Vac

Complies: ☒ YES ☐ NO

Tested By:	John Robins	Signature or initials:	<i>JR</i>	Comp. Date:	12/6/16
Reviewed By:	cwm	Signature or initials:	<i>cwm</i>		
Test Equipment Used:	16,18,19				
Amb (°f):	72	RH%	28		

Transient Voltage Immunity 6.4.6.4

Three samples were subjected to 3 positive and 3 negative 1000V 7.5 joule pulses across their input leads at a rate of 0.5 pps in accordance with NEMA TS 2-2003 section 2.1.8. The pulses were the discharge from a 15µF capacitor. The devices were then energized with rated voltage to verify proper operation.

Results

The signal modules withstood the applications of the transient voltage without damage or operational deterioration.

12" Yellow Ball			
Sample	3 Positive Pulses	3 Negative Pulses	Results
CRT1610241001-004-002	x	x	Pass
CRT1610241001-004-003	x	x	Pass
CRT1610241001-004-004	x	x	Pass

Measured Voltage:	1000	Vdc
Measured Capacitance:	15.8 - 16.6	µF

Complies: ☒ YES ☐ NO

Tested By:	Kurt Dobler	Signature or initials:	kfd	Comp. Date:	12/8/16
Reviewed By:	cwm	Signature or initials:	<i>[Signature]</i>		
Test Equipment Used:	2,16				
Amb (°f):	72	RH%	30		

Electronic Noise 6.4.6.5

Three LED traffic signal modules were operated at 120 VAC/60Hz throughout the test. Emissions measurements were taken to compare values to applicable requirements.

Results

The emissions complied with the requirements of the referenced specification. The testing was performed at our Oakdale, MN office. See report: 102472631MIN-014Y

Complies: ☒ YES ☐ NO

Tested By:	Richard Blonigen	Signature or initials:	See Report	Comp. Date:	12/21/16
Reviewed By:	Uri Specor	Signature or initials:	See Report		
Test Equipment Used:	See Report				
Amb (°C):	See Report	RH%:	See Report		

Power Factor & Total Harmonic Distortion 6.4.6.6 & 6.4.6.7



Three tinted samples were measured for power factor and total harmonic distortion. A commercially available power analyzer was used to perform these measurements.

Results

12" Yellow Ball						
Sample	Voltage	Current (mA)	Power (W)	Power Factor	THD V%	THD I%
CRT1610241001-004-001	119.9	74.8	8.9	0.95	0.79	14.6
CRT1610241001-004-002	119.9	77.2	8.9	0.96	0.82	14.5
CRT1610241001-004-003	120.1	78.6	8.9	0.95	0.80	16.6
Requirement	NA	NA	NA	≥ 0.90	≤ 20%	≤ 20%

Measurements taken after a minimum 60 minute warmup.

Complies: ☒ YES ☐ NO

Tested By:	John Robins	Signature or initials:		Comp. Date	11/8/16
Reviewed By:	cwm	Signature or initials:			
Test Equipment Used:	15,16	Sample No:	above		
Amb (°f):	72	RH%	30		

Load Switch Compatibility 6.4.7.1

Three samples were connected to a variable AC voltage supply. The sample was monitored for sufficient current draw to ensure proper load switch operation while the voltage is varied from 80V rms to 135 V rms.

Results

The load switch data is provided to the client to determine if the current draw is acceptable. The referenced ITE specification does not list a minimum current draw requirement. As a result, the Caltrans Standard Specifications dated 2010, Section 86-4.01D(2)(a) must be followed listing a minimum power consumption requirement of 5 watts for 12" traffic signal modules.

12" Yellow Ball		
Sample	80 Vrms	135 Vrms
CRT1610241001-004-001	106.5	70.3
CRT1610241001-004-002	106.3	71.6
CRT1610241001-004-003	106.9	70.3



Current measurements are in mA

12" Yellow Ball		
Sample	80 Vrms	135 Vrms
CRT1610241001-004-001	8.2	9.1
CRT1610241001-004-002	8.2	9.1
CRT1610241001-004-003	8.2	9.0

Power measurements are in watts.

Measured Voltage 80Vac:	80.1	Vac
Measured Voltage 135Vac:	135.0	Vac

Complies: ☒ YES ☐ NO

Tested By:	John Robins	Signature or initials:		Comp. Date:	11/9/16
Reviewed By:	cwm	Signature or initials:			
Test Equipment Used:	15,16				
Amb (°C):	73	RH%	38		

Off State Voltage Decay 6.4.7.2

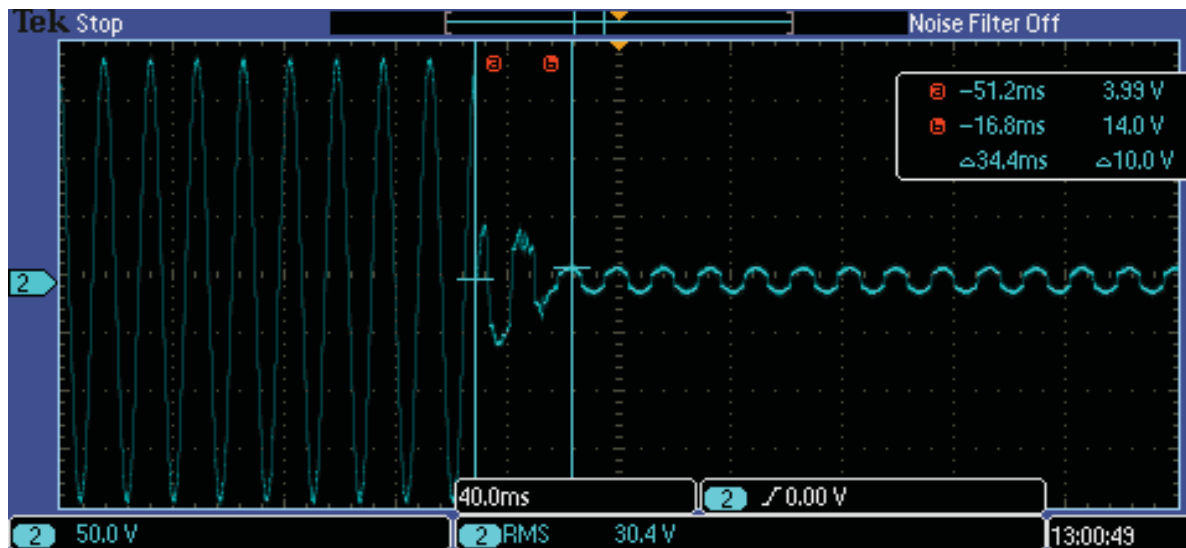
Three samples were operated from a 135V AC voltage supply. A 19.5 k-ohm resistor was wired in series in the hot line between the LED signal monitor and the AC power supply. A single-pole-single-throw switch was wired in parallel across the 19.5 k-ohm resistor. A 220 k-ohm shunt resistor was wired between the hot line connection and the neutral line connection on the LED signal module. The single-pole-single-throw switch was closed, shorting out the 19.5 k-ohm resistor, allowing the AC power supply to illuminate the LED signal module. Next the switch was opened and the voltage across the 220 k-ohm shunt resistor was measured for a decay to a value equal to or less than 10V rms within a time period equal to or less than 100 milliseconds. The test was repeated a sufficient number of times to ensure testing occurs at the peak of the AC line voltage cycle.

Results

12" Yellow Ball	
sample	Decay Time (mS)
CRT1610241001-004-001	32.0
CRT1610241001-004-002	32.8
CRT1610241001-004-003	34.4

In all samples measured the decay time was less than 100mS.

Sample Screen Shot



Measured Voltage: 135 Vac

Complies: ☒ YES ☐ NO

Tested By:	John Robins	Signature or initials:	<i>JR</i>	Comp. Date:	12/7/16
Reviewed By:	cwm	Signature or initials:	<i>cwm</i>		
Test Equipment Used:	16,18,19				
Amb (°f):	72	RH%	29		

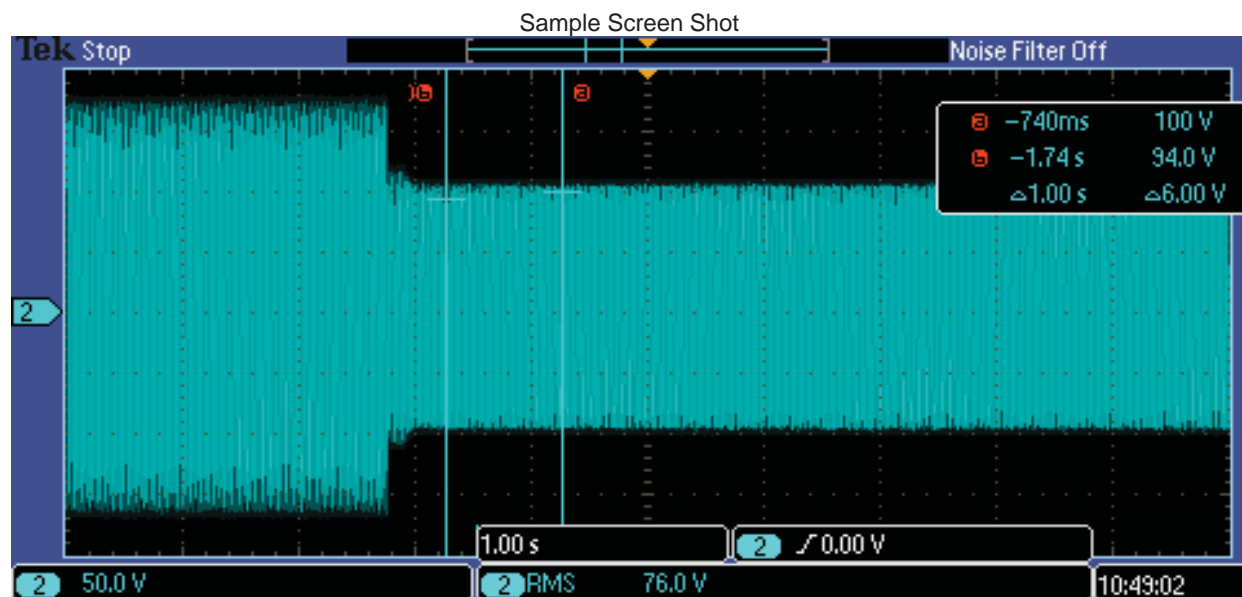
Failed State Impedance 6.4.8

First the LED board is disconnected from the signal power supply. Then the LED signal modules are operated from a 120V AC voltage supply. A 50k-ohm resistor is wired in series in the hot line between the LED signal module and the AC power supply. A single-pole-single-throw switch is wired in parallel across the 50k-ohm resistor. A 100 k-ohm shunt resistor is wired between the hot line connection and the neutral line connection on the LED signal module. The single-pole-single-throw switch is opened and the voltage across the 100 k-ohm shunt resistor is measured from 500mS through 1500mS, after energizing the circuit with the open switch. The test was repeated 10 times.

Results

12" Yellow Ball	
sample	Vrms
CRT1610241001-004-001	75.8
CRT1610241001-004-002	76.0
CRT1610241001-004-003	75.9

In all samples tested the voltage across the 100K Ω resistor was greater than 70 Vac RMS.



Measured Voltage: 120 Vac

Complies: ☒ YES ☐ NO

Tested By:	John Robins	Signature or initials:	<i>JR</i>	Comp. Date:	2/27/17
Reviewed By:	JND	Signature or initials:	<i>JND</i>		
Test Equipment Used:	16,18,19				
Amb (°f):	72	RH%	24		

Equipment list				
#	Intertek ID No.	Description	Manufacturer	Calibration Due
1	H204	Chamber	Thermotron	10-Nov-2017
2	M207	Digital Multimeter	Fluke	17-Sep-2017
3	T1486	Digit Hygro-Thermometer	Extech	16-Mar-2017
4	V272	Signal Conditioner	Unholtz-Dickie	27-Jun-2017
5	V393	Vibration Controller	Unholtz-Dickie	15-Jul-2017
6	V328	Accelerometer	PCB Piezotronics	2-Dec-2016
7	V334	Accelerometer	PCB Piezotronics	18-Feb-2017
8	O109	Goniometer	Optroniks	3-Oct-2017
9	O115	25M Photometer	Optroniks	24-Oct-2017
10	T1555	Hygro-Thermometer	Extech	3-May-2017
11	M135	Multimeter	Fluke	4-Apr-2017
12	O757	Spectra Scan	Photo Research	23-Mar-2017
13	R153	Distance Meter	Leica	7-Dec-2016
14	O719	flexOptometer	UDT	3-Dec-2016
15	G032S	Power Analyzer	Yokogawa	9-May-2017
16	T835	Temp/Humidity	Supco	10-Jun-2017
17	T804	Digital Thermometer	Fluke	16-May-2017
18	V244	High Voltage Probe	Tektronix	3-Nov-2017
19	E470	Oscilloscope	Tektronix	8-Jul-2017
20	S159	Push Pull Scale	Controls International	7-Jan-2017
21	N1153	Rain Gauge	Pyrex	6-Jan-2019
22	T804	Thermometer	Fluke	16-May-2017
23	N1419	Stopwatch	Control Co	16-Aug-2017
24	Y205	Anemometer	Omega	23-May-2017
Note: For measurement uncertainty, refer to the calibration certificates for all the test equipment located in the equipment files				

GOAL DETERMINATION REQUEST FORM

Buyer Name/Phone	Michelle Pearson 42023	PM Name/Phone	Ramona Aguilar 47050
Sponsor/User Dept.	2400	Sponsor Name/Phone	n/a
Solicitation No	IFB 2400 MDP0263	Project Name	LED Traffic Signal Lamps
Contract Amount	\$125,000	Ad Date (if applicable)	04/09/2018
Procurement Type			
<input type="checkbox"/> AD – CSP <input type="checkbox"/> AD – Design Build Op Maint <input type="checkbox"/> IFB – IDIQ <input type="checkbox"/> Nonprofessional Services <input type="checkbox"/> Critical Business Need <input type="checkbox"/> Sole Source*			
<input type="checkbox"/> AD – CM@R <input type="checkbox"/> AD – JOC <input type="checkbox"/> PS – Project Specific <input checked="" type="checkbox"/> Commodities/Goods <input type="checkbox"/> Interlocal Agreement			
<input type="checkbox"/> AD – Design Build <input type="checkbox"/> IFB – Construction <input type="checkbox"/> PS – Rotation List <input type="checkbox"/> Cooperative Agreement <input type="checkbox"/> Ratification			
Provide Project Description**			
As needed purchases of LED traffic signal lamps and bicycle signal lamps			
Project History: Was a solicitation previously issued; if so were goals established? Were subcontractors/subconsultants utilized? Include prior Solicitation No.			
Yes, solicitation #SDC0243 in the year 2012. Contract #MA 2400 GA120000100. No subcontracting goals were identified, therefore no goals were established for that solicitation.			
List the scopes of work (commodity codes) for this project. (Attach commodity breakdown by percentage; eCAPRIS printout acceptable)			
55088 = 100%			
Michelle Pearson		03/29/2018	
Buyer Confirmation		Date	

* Sole Source must include Certificate of Exemption

**Project Description not required for Sole Source

FOR SMBR USE ONLY			
Date Received	3/29/18	Date Assigned to BDC	3/30/18
In accordance with Chapter 2-9(A-D)-19 of the Austin City Code, SMBR makes the following determination:			
<input type="checkbox"/> Goals	% MBE	% WBE	
<input type="checkbox"/> Subgoals	% African American	% Hispanic	
	% Asian/Native American	% WBE	
<input type="checkbox"/> Exempt from MBE/WBE Procurement Program		<input checked="" type="checkbox"/> No Goals	

GOAL DETERMINATION REQUEST FORM

This determination is based upon the following:

- | | |
|--|---|
| <input type="checkbox"/> Insufficient availability of M/WBEs | <input type="checkbox"/> No availability of M/WBEs |
| <input type="checkbox"/> Insufficient subcontracting opportunities | <input checked="" type="checkbox"/> No subcontracting opportunities |
| <input type="checkbox"/> Sufficient availability of M/WBEs | <input type="checkbox"/> Sufficient subcontracting opportunities |
| <input type="checkbox"/> Sole Source | <input type="checkbox"/> Other |

If Other was selected, provide reasoning:

MBE/WBE/DBE Availability

1 certified firm in SLBP

Subcontracting Opportunities Identified

None; commodity purchase

Cynthia Van Maanen	<i>Cynthia Van Maanen</i> 3/30/18
SMBR Staff	Signature/ Date
SMBR Director or Designee	Date 4-2-18
Returned to/ Date:	